BOONTON ELECTRONICS CORPORATION

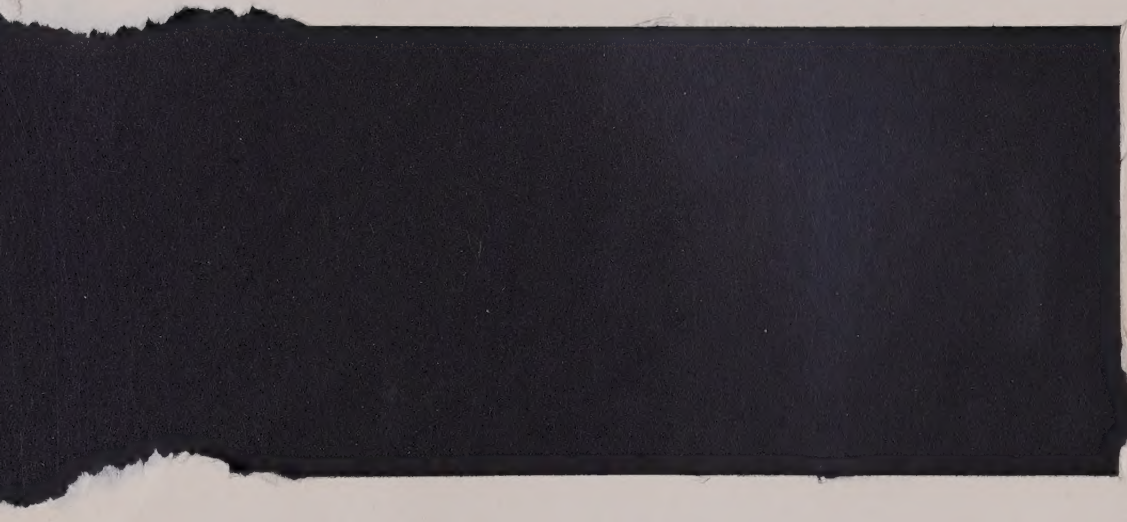
June 89

Model 42B

RF MICROWATTMETER

Instruction Manual

a-873



Model 42B

RF MICROWATTMETER

Instruction Manual

a-873

BOONTON ELECTRONICS CORPORATION

TEL: 201-887-5110
TWX: 710-986-8241

ROUTE 287 AT SMITH ROAD
PARSIPPANY, N.J. 07054 USA

BOONTON ELECTRONICS
MICROWATTMETER
FULL SCALE
PWR
dBm
dBm
1mW Zo
POWER
10mW
+10
1mW
0
100µW
−10
10µW
−20
1µW
−30
100nW
−40
10nW
−50
MODEL 42B
CAL FACTOR
POWER DETECTOR
ZERO
0.5
0.5
dBm
PWR
ON
BOONTON ELECTRONICS CORPORATION
POWER DETECTOR
MODEL 41-
4B
INPUT Z = 50Ω
SERIAL NO.
X7
BOONTON ELECTRONICS

TABLE OF CONTENTS

CHAPTER			PAGE
I	GENERAL INFORMATION		1
	1.1	GENERAL	1
	1.2	EQUIPMENT DESCRIPTION	1
	1.2.1	Frequency Range	2
	1.2.2	Power Range	2
	1.2.3	Response	2
	1.2.4	Noise	2
	1.2.5	Zero Adjustment	2
	1.2.6	Calibration Factor Adjustment	2
	1.2.7	Analog Output	2
II	SPECIFICATIONS		3
III	OPERATION		5
	3.1	INSTALLATION	5
	3.2	OPERATION	6
	3.2.1	Initial Operating Procedure	6
	3.2.2	Connection Recommendations	6
	3.2.3	Low-Level Measurements	6
	3.2.4	High-Level Measurements	7
	3.2.5	High-Frequency Measurements	7
	3.2.6	Temperature Effects	7
	3.2.7	VSWR Measurements	7
	3.2.8	Shielding Recommendations	9
	3.2.9	External Programming	9
	3.2.10	DC Output	9
IV	CIRCUIT DESCRIPTION		
	4.1	GENERAL	11
	4.1.1	Power Detector	11
	4.1.2	Attenuator and Amplifiers	11
	4.1.3	Synchronous Detector	11
	4.1.4	Shaping Amplifier	11
	4.1.5	Chopper Driver	11
	4.1.6	Power Supply	12
	4.1.7	Programming	12
	4.1.8	Meter Shaping	12
	4.1.9	Linear dBm Option	12
V	MAINTENANCE		13
	5.1	PERIODIC CALIBRATION	13
	5.2	LOW FREQUENCY CALIBRATION CHECK	13
	5.2.1	All Ranges Except +10 dBm	13
	5.2.2	+10 dBm Range	13
	5.3	CALIBRATION PROCEDURE, 42B	15
	5.4	CALIBRATION PROCEDURE, 42B-18	16

5.5 CALIBRATION PROCEDURE, 42B-19 16
5.6 TROUBLE-SHOOTING PROCEDURE 17
5.6.1 Chopper Replacement 17
5.6.2 Voltage and Resistance Tests 17
5.6.3 Power Detector Replacement 17
5.7 HIGH FREQUENCY CALIBRATION CHECK 17
5.7.1 Calibration Factor and Effective Efficiency 17
5.7.2 Determination of Calibration Factor 20
5.7.3 Determination of Effective Efficiency 31
5.8 POWER DETECTOR REPAIR 22

ILLUSTRATIONS

FIGURE NO.		PAGE
1	Typical VSWR Curve	4
2	Detector Temperature Characteristic	8
3	System Temperature Characteristic	8
4	dB/VSWR Conversion Chart	10
5	DC Output Correction Curve	10
6	Block Diagram	12
7	Connections, Calibration Check	14
8	Connections, Calibration Check	14
9	dB Uncertainty Graph	18
10	% Uncertainty Graph	19
11a	Calibration Factor Connections	20
11b	Calibration Factor Connections	20
11c	Calibration Factor Connections	21
12	Effective Efficiency Connections	21
13	Power Detector	23
14	External Connections	24

List of Replaceable Parts 25

CHAPTER 1
General Information

1.1 GENERAL

One of the 42 Series instruments, the Model 42B provides accurate, sensitive, and stable measurement facilities for rf power from the low radio frequencies to the microwave region (200 kHz to 18 GHz). The power range of this instrument covers from one nanowatt to ten milliwatts (-60 dBm to +10 dBm).

The Model 42B is a solid-state, programmable instrument of high sensitivity, low input vswr, and low noise. Because it does not depend upon thermal sensing devices, it exhibits a very high degree of stability and ease of adjustment. The panel meter is calibrated in terms of both power and dBm. In addition, a dc voltage proportional to the input power is available at a rear-panel connector. This feature allows the instrument to drive recorders, remote indicators, or similar analog devices. Logic-level programming using standard TTL logic permits easy integration with complete test systems.

The 42B is useful for making a wide variety of measurements. Representative uses of this versatile instrument include:

Adjustment of low-power transmitters, signal generators, and oscillators.

VSWR and return-loss measurements with directional couplers and slotted lines.

Gain measurements on travelling-wave tubes.

Measurements of vswr and attenuation of rf attenuators.

Antenna adjustments.

The standard features of the instrument include:

Logic-level programmability

Calibration factor control

DC analog output

Low vswr

Convenient push-button ranging

Overload protection to 300 milliwatts

Measurement range from one nanowatt to ten milliwatts.

The optional features of the instrument include:

Linear dBm scale and dc output linear with db

Linear power scales and dc output linear with power

The basic characteristics of all versions of the 42B include high reliability, high stability, fast warm-up, plug-in printed-circuit board construction for ease of servicing or modification, light weight, and other advantages of the solid-state design.

1.2 EQUIPMENT DESCRIPTION

The Model 42B RF Microwattmeter, unlike most instruments of its kind, determines rf power by measuring the voltage appearing across a precision non-inductive resistor in the Power Detector head. The panel meter, of course, is calibrated in terms of power according to the relationship $P=E^2/R$. This detection system has important performance advantages over conventional power meters using bolometer or thermocouple detection. Sensitivity of 1 nW (-60 dBm) is orders of magnitude better; temperature stability of less than 0.01 dB/°C supports this sensitivity; and, burnout levels above 300 mW reduces the most common cause of detector failure.

The instrument is available with a range of options and Power Detectors, listed in Section 2: SPECIFICATIONS. For all options, input range programming can be controlled by TTL logic or PNP transistors to ground. The Model 42B is sensitive, accurate, sturdily built, and well protected against accidental overloads. Performance over long periods of time without failure or need for recalibration is standard.

The Model 42B is packaged as a compact bench instrument, with a combination carrying handle and adjustable-angle mounting foot. Should rack mounting be preferred, hardware kits to accommodate either one or two instruments are available. For the operator's convenience, essential accuracy and vswr information is reproduced on

a reference plate attached to the outside top cover of the instrument. Brief calibration instructions are reproduced on the underside of the top cover.

The Model 42B is normally ordered with one of the following Power Detectors:

Model 41-4A	200 kHz to 7 GHz
Model 41-4B	200 kHz to 12.4 GHz
Model 41-4C	200 kHz to 1 GHz (75 Ω)
Model 41-4E	200 kHz to 18 GHz

1.2.1 Frequency Range

The calibrated frequency range extends from 200 kHz to 18 GHz, depending upon the particular Power Detector used. Useful response for relative measurements can be obtained from 20 kHz to approximately 20 GHz.

1.2.2 Power Range

With any of the Power Detectors, the Model 42B will measure power from one nanowatt up to ten milliwatts. Temporary overloads up to 300 milliwatts will do no permanent harm to the instrument or the Power Detector. When measuring the average power of pulsed signals, the accuracy is good up to 30 microwatts peak power. The power capabilities of the 42B can be increased by the use of external attenuators.

1.2.3 Response

At low power levels the detector diodes operate in the square-law region; the instrument response is to the true average power of CW, AM, FM, and pulsed signals. Above the transition level of approximately ten microwatts response tends towards the peak value, although the panel meter is calibrated in terms of average power, and the instrument will correctly indicate the true average power of CW and FM signals.

1.2.4 Noise

The Model 42B has been designed and constructed to hold noise from all sources to a minimum. The Power Detector cable is of special low-noise design; a vigorous flexing causes only momentary, minor deflections on the most sensitive range of the instrument. The Power Detectors are not sensitive to shock or vibration; even sharp tapping on the detector barrel causes no visible deflection on any range.

Amplification takes place at 94 Hz, reducing susceptibility to 50 or 60 Hz fields. A unique circuit reduces the low-level noise originating in the mechanical chopper and renders the instrument immune to changes in chopper performance that could occur with the passage of time.

1.2.5 Zero Adjustment

Zero adjustment is normally not required on the upper ranges of the Model 42B. For measurement on the lower ranges, the ZERO control is set on the most sensitive range before using. This control balances out small thermal voltages in the sensing elements and, once adjusted, requires only infrequent checking during the course of subsequent measurements.

1.2.6 Calibration Factor Adjustment

A panel-mounted control allows the sensitivity of the instrument to be adjusted in 0.1 dB steps to correct for the frequency response and mismatch errors of the detector. Calibration is in terms of indicated power to incident power.

1.2.7 Analog Output

The Model 42B provides a dc output voltage corresponding to the power being measured. The current capability of 1 mA into 1000 ohms is extremely stable. When used as part of an automatic test system, the fast response of the instrument's dc output to an input step function allows more tests per unit time. DC output as normally supplied is linear with power. A special option -18 provides a dc output linear with dB.

Power Range:

One nW (-60 dBm) to 10 mW (+10 dBm) in seven ranges:

Full Scale Power Ranges:

10 nW, 100 nW, 1 μW, 10 μW, 100 μW, 1 mW, 10 mW.

Full Scale dBm Ranges:

-50, -40, -30, -20, -10, 0, +10.

Frequency Range:

0.2 MHz to 18 GHz with 41-4E Detector
0.2 MHz to 12.4 GHz with 41-4B Detector
0.2 MHz to 7 GHz with 41-4A Detector
0.2 MHz to 1 GHz with 41-4C Detector (75 Ω)

Accuracy:

10 nW to 10 mW (-50 to +10 dBm)	0.5% fs Plus		
	0.2 dB	0.3 dB	0.4 dB

With 41-4B: 0.2 MHz 4 GHz 8.2 GHz 12.4 GHz
With 41-4A: 0.2 MHz 4 GHz 7.0 GHz
With 41-4C: 0.2 MHz 1 GHz

1 nW to 10 nW (-60 to -50 dBm)	1% fs Plus		
	0.4 dB	0.6 dB	0.8 dB

With 41-4B: 0.2 MHz 4 GHz 8.2 GHz 12.4 GHz
With 41-4A: 0.2 MHz 4 GHz 7.0 GHz
With 41-4C: 0.2 MHz 1 GHz

Accuracy (with 41-4E Head):

10 nW to 10 mW (-50 to +10 dBm)	0.5% fs Plus		
	0.2 dB	0.4 dB	0.6 dB

0.2 MHz 4 GHz 12.4 GHz 18 GHz

1 nW to 10 nW (-60 to -50 dBm)	1% fs Plus		
	0.4 dB	0.6 dB	0.8 dB

0.2 MHz 4 GHz 12.4 GHz 18 GHz

Temperature: In accordance with ANSI (ASA) Spec. 39.7

Temp. Range	Influence	
	Model 42B	Detector
Ref. 21°C - 25°C	0	0
Normal, 18°C - 30°C	0	±0.1 dB
Severe, 10°C - 40°C	±0.2 dB	±0.2 dB

Power Detectors:

Input Connection: Type N (Precision)
Output Connector: To fit 41-2A cable
Dimensions: 1.5" (38 mm) diameter; 3.5" (90 mm) length

	Model 41-4A	Model 41-4B	Model 41-4C	Model 41-4E
Input Imp.	50 Ω	50 Ω	75 Ω	50 Ω
Freq. Range	0.2 MHz/7 GHz	0.2 MHz/12.4 GHz	0.2 MHz/1 GHz	0.2 MHz/18 GHz
VSWR	<1.3 to 4 GHz <1.4 to 7 GHz	<1.3 to 4 GHz <1.4 to 11 GHz <1.6 to 12.4 GHz	<1.3 to 1 GHz	<1.3 200 kHz/4 GHz <1.5 4 GHz/10 GHz <1.7 10 GHz/18 GHz

Meter:

4-1/2 inch taut-band
Two scales: dBm and Power
Top Scale (Red): -11 to 0 dBm, 0.2 dB or 0.5 dB divisions.
Bottom Scale (Black): 1 to 10 with 1% or 2% divisions.

Meter Unrest:

10 nW (-50 dBm) range:
Above 4 nW: 1% fs max.
1 to 4 nW: 2% fs max.

Waveform Response:

Input level 1 nW to 10 μW: True average power.
Input level above 10 μW: Average power of sine wave (true rms response changing to peak response).

Analog Output:

0 to +10 volts on each range, proportional to the input power. Source resistance 9 kΩ. 1 mA maximum into 1000 Ω load.

Response time to full-scale step function:

10 μW (-20 dBm) to 10 mW (+10 dBm) fs: 100 ms max.
Below 10 μW to 10 nW (-50 dBm) fs: 1 second max.

Programming:

Input range selected by standard TTL logic (logic low 0 to 0.7 volts referred to ground). A manual disable contact allows the range switch to be disabled during remote programming.

Power Requirements:

115 or 230 volts ±10%, 50 to 400 Hz, 8 watts.

Dimensions:

6.0" (152 mm) high, 8.3" (211 mm) wide, 12.0" (305 mm) deep.

Weight:

Net 7 lbs. (3.2 kg) with standard accessories.
Shipping weight 14 lbs. (6.4 kg).

Accessories Supplied:

5-foot power detector cable Model 41-2A.

Equipment Options:

Model 42B-11: Reverse scale option; power scale at top, dBm scale at bottom.
Model 42B-08: Rear signal input.
Model 42B-18: Linear dBm option, linear dBm scale. DC output 1 volt/dB (0 to 10 V).
Model 42B-19: Linear power scale uppermost.

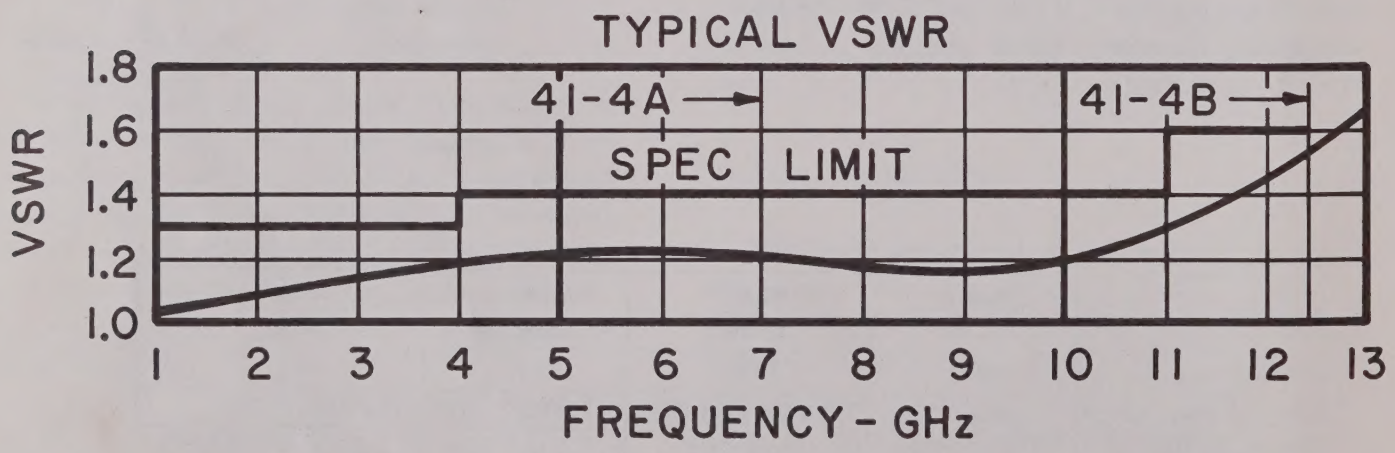


Figure 1. Typical VSWR

Chapter III
Operation

3.1 INSTALLATION

Each instrument has been tested and inspected at the factory for compliance with all specifications before packing. Unpack carefully, saving all packing materials for possible future reshipping, and inspect the instrument for any signs of shipping damage. Should any damage be evident, notify the carrier and the factory immediately.

Although the Model 42B is a simple instrument to use, and operation is largely self-evident, it is recommended that the table of controls and functions, as well as the operating procedure, be studied before commencing operation.

Table 1

Controls & Functions

ITEM	FUNCTION
PWR ON	This push-button switch controls the ac power to the instrument's power supply.
FULL SCALE	These range push-buttons select the operating range of the instrument. They are arranged in the sequence 10 nW, 100 nW, 1 μW, 10 μW, 100 μW, 1 mW and 10 mW full scale.
Meter	A 4-1/2 inch taut-band meter with a linear power scale reading 1 to 10 with 1% or 2% divisions, and a logarithmic dBm scale reading -10 to 0 dBm, with 0.2 or 0.5 dB divisions.
POWER DETECTOR	The Power Detector cable is connected to the instrument's input via this connector. It should be noted that if the instrument is a Model 42B-08 option, there will be an additional input connector on the rear apron. The panel connector will have a screw-on shield cap; both input connectors are usable.
ZERO	This control is used to zero the instrument electrically. (There is also a mechanical zero-setting screw on the front of the meter housing.)
CAL FACTOR	This calibration factor control enables the operator to compensate for frequency effect. For a given measurement frequency, the control is set to the figure indicated on the chart found on the barrel of the Detector Head. The resultant reading may then be used directly, with no further correction.
(The following items are on the rear panel.)	
Fuse Holder and Fuse	This contains the ac line fuse - either a 0.1 ampere, 115 volt, or 0.06 ampere, 230 volt Bussman MDL SLO-BLO fuse.
Slide Switch	This connects the power transformer primary windings either in parallel for 115 volt lines, or in series for 230 volt lines.
RECORDER	A dc voltage proportional to the applied power level is available at these terminals for connection to external devices. Full-scale output is +10 volts on each range. Output resistance is 9000 ohms.
Remote Connections	A card-edge type connector is accessible through a slot in the rear panel. The mating connector should be an Amphenol type 225-22221-101 or equivalent. See Figure 7 for pin designations.

This safety requirement has been adopted by the International Electrotechnical Commission Document 66 (Central Office) 3, paragraph 5.3, and indicates that is is necessary to refer to the instruction manual for correct use of the instrument.

3.2 OPERATION

The initial operating procedure detailed below should be followed carefully before attempting to use the instrument for measurement work.

3.2.1 Initial Operating Procedure

a. Compare the serial numbers of the Power Detector to be used and of the instrument; they should be the same. Each 42B is calibrated with its own Power Detector; using another detector may result in measurement errors unless the instrument is recalibrated.

b. Check the setting of the power switch on the rear panel to be sure that it is set to the correct position for the power line voltage. See that the proper fuse for this voltage is in the fuseholder.

c. Connect the Power Detector cable to the POWER DETECTOR connector on the panel, screwing the knurled clamping nut firmly home, and attach the Power Detector to the cable.

d. If necessary, adjust the panel meter zero with the zero-screw below the meter face.

e. Set the CAL FACTOR control to 0 dBm.

f. Press the PWR ON button and allow the instrument to warm up for a few minutes.

g. Press the 10 nW FULL SCALE button. If the meter pointer does not remain at the red/black zero reference mark at the extreme left-hand end of the scale, use the ZERO control to adjust it. Because of the instrument's sensitivity on this range, indicator fluctuations of up to +0.5 dB can be expected. Proper zero adjustment is reached when the pointer fluctuates evenly around the zero reference mark. If the Detector is in a strong power-line or noise field, zeroing can be difficult. In this situation, refer to Par. 3.2.8 for shielding instructions.

It is important that the Detector be in thermal equilibrium. For this reason, prolonged handling of the Detector should be avoided before or during this adjustment.

3.2.2 Connection Recommendations

Although the Power Detectors are carefully insulated against external temperature variations, it is advisable to locate the Detector away from any sources of heat when using the most sensitive ranges. If monitoring the output of equipment which generates heat significantly above the ambient temperature, the Power Detector could be connected by a sufficient length of cable to allow free circulation of air, rather than being fixed directly to a warm output connector. If this is done, however, the cable length must be kept as short as possible, and operation should not be attempted at the high end of the frequency range. Cable losses and increase in vswr will tend to degrade the accuracy of the measurements. In either event, sufficient time should be allowed for the total assembly to reach thermal equilibrium before making any measurements.

3.2.3 Low-Level Measurements

The Model 42B will provide reliable, reproducible measurements of CW, AM, and FM power levels as low as 1 nanowatt (-60 dBm). It can also be used, although with slightly decreased accuracy (±1 dB) for pulse measurements. The peak power in this mode should not exceed 30 μW (-15 dBm), however. Above this level the detector enters the region where it functions as a peak detector; accuracy, except for CW and FM, cannot be guaranteed under these conditions.

When using the three most sensitive ranges (10 nW,

100 nW, and 1 μW), the preliminary zero adjustment is required. (See Par. 3.2.1)

3.2.4 High-Level Measurements

When using the higher ranges of the 42B (10 μW to 10 mW), it is not necessary to make the zero adjustment. As noted in Par. 3.2.3 above, accuracy cannot be guaranteed when measuring pulse power with peaks exceeding 30 μW. For CW and FM power, measurements within the specified accuracy will be obtained up to 10 mW.

3.2.5 High Frequency Measurements

To obtain the specified accuracy of the 42B at frequencies above 1 GHz, reference must be made to the correction chart on the barrel of the Power Detector. This curve, which is individually determined for each Power Detector, presents a correction factor vs frequency which must be applied to the instrument reading. While this can be done by adding algebraically the correction to the reading, use of the CAL FACTOR control automatically inserts the correction and enables the operator to read the meter directly. This control is adjusted as follows:

Read the correction to be applied at the frequency of operation from the curve on the Detector Barrel. As an example, say that the indicated value is +0.2 dBm. Set the CAL FACTOR control to +0.2 dBm. All values thereafter, at that frequency, are then read directly from the meter, with no further correction needed. Note that if the frequency of measurement is changed, a new CAL FACTOR setting will be required.

NOTE: The Model 41-4A, 41-4B, and 41-4E Power Detectors are calibrated for use with a 50-ohm source. Large deviations from 50 ohms may give rise to serious errors from mismatch and increased vswr. This effect can be reduced by inserting a low-vswr attenuator (vswr < 1.10) between the source and the Power Detector; an alternative would be the insertion of a low-loss tuner.

The Model 41-4C Power Detector is calibrated for use with a 75-ohm source. The same comments apply in this case.

3.2.6 Temperature Effects

The accuracy specifications for the Model 42B apply over an ambient temperature range of 18°C to 30°C. Operation outside this temperature range is possible, but some inaccuracy can be expected. Figure 2 shows a typical temperature characteristic of a Power Detector, and Figure 3 shows that of a Model 42B and Power Detector together.

NOTE: For best zero stability, the Power Detector and instrument should be allowed to reach a stable temperature.

3.2.7 VSWR Measurements

The high upper-frequency limits and the sensitivity of the Model 42B make it a useful instrument for measuring vswr with a slotted line. As this type of measurement requires only comparative, rather than absolute, values, the 42B may be used up to 18 GHz (up to 20 GHz with the Model 41-4E Detector).

VSWR is determined by measuring the dB difference between a maximum and a minimum power point on a slotted line and converting this difference to vswr. An adapter is needed to couple the instrument to the slotted line; these are usually available from the manufacturer of the particular slotted line used.

Slotted-line vswr measurements may be made as follows;

a. Connect the Power Detector to the sliding carriage, using a suitable adapter.

b. With the signal source OFF, zero the Model 42B.

c. Turn the signal source on, and slide the carriage along the line until a maximum power point is located.

d. Adjust the source level and the probe setting for the least coupling that will yield a reading of -41 dBm. (The incident power should be 0 dBm or greater.)

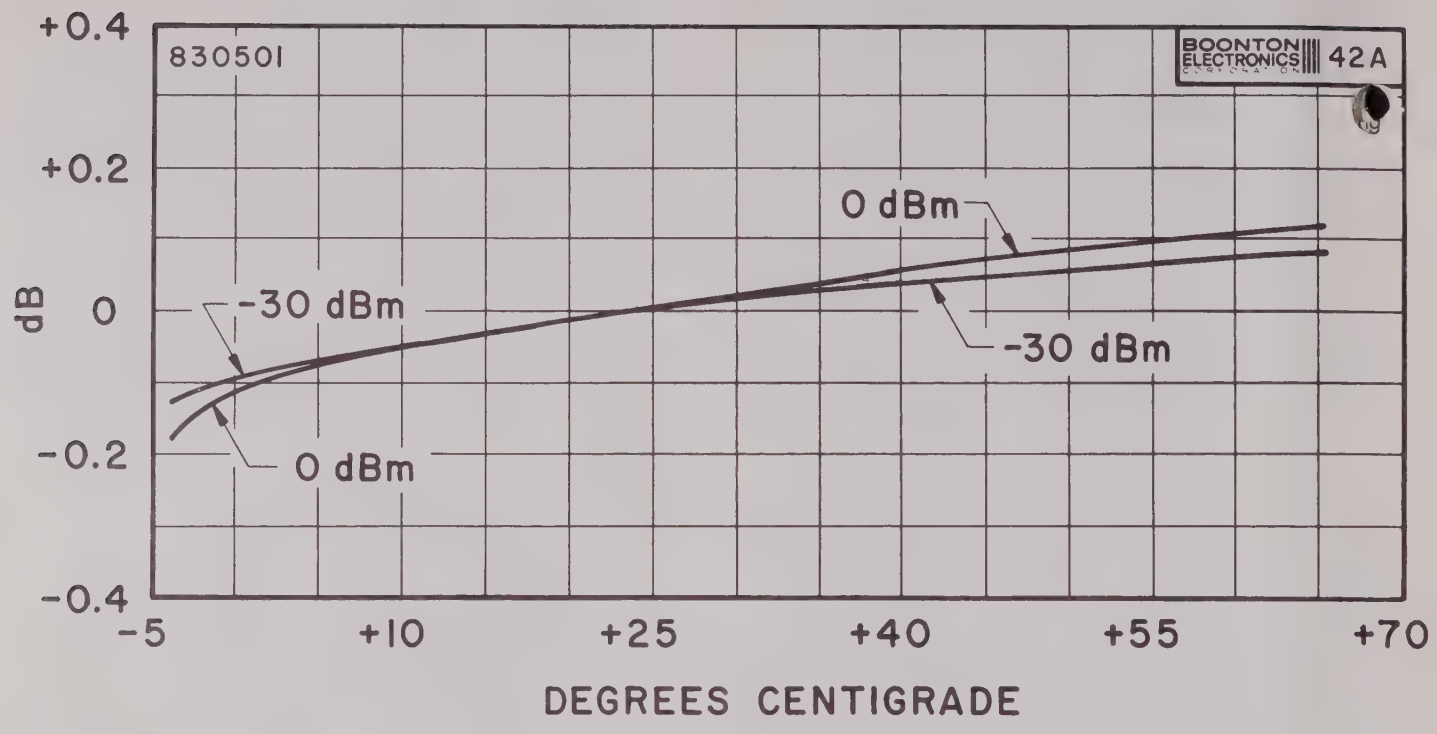


Figure 2. Detector Temperature Characteristic

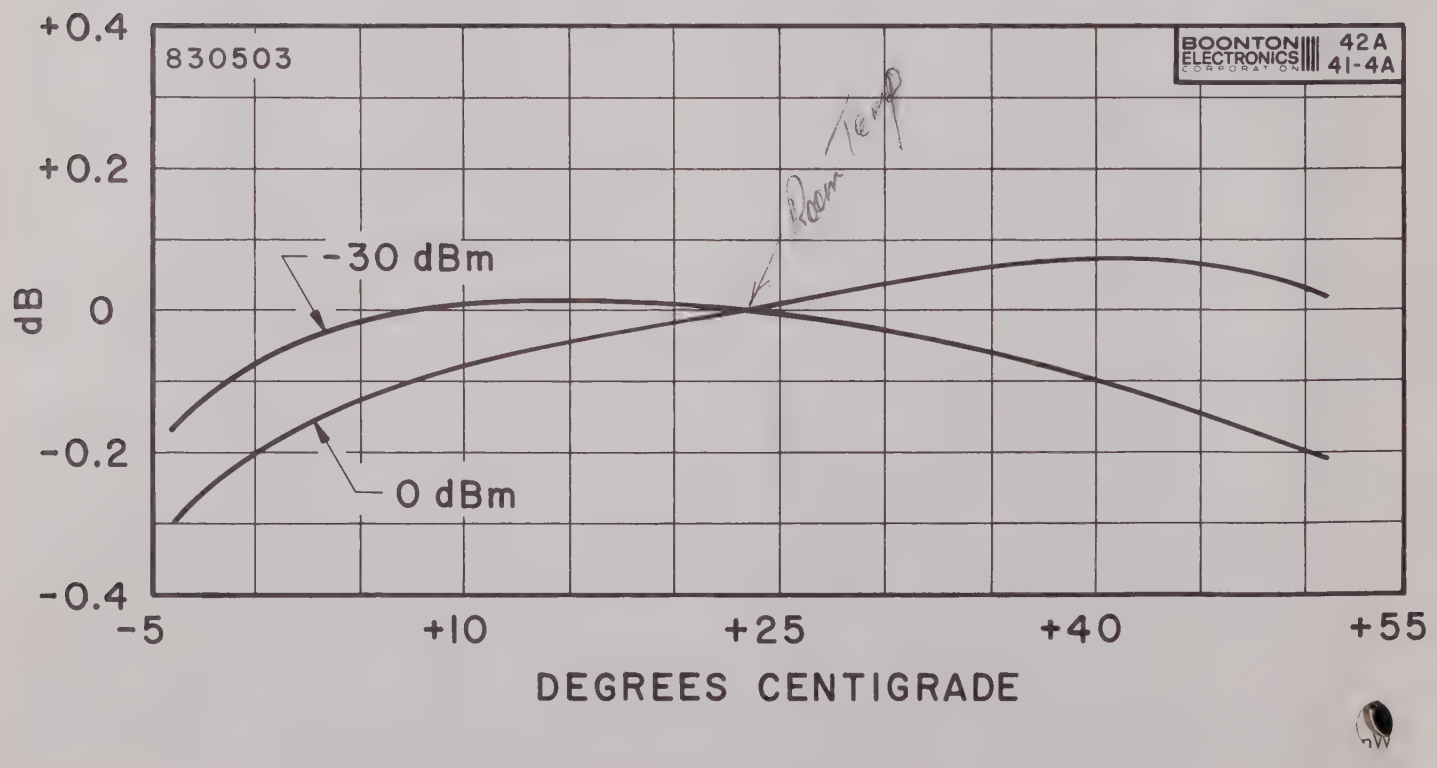


Figure 3. System Temperature Characteristic

e. Slide the carriage along the line to locate a point of minimum power. Note the meter reading (dBm) at this point, then subtract this minimum reading from the maximum reading, ignoring signs. Convert the resultant Δ dB into vswr, either by the use of the vswr Conversion Curve (Figure 4) or by computation.

NOTE: VSWR is the antilog, base 10, of ΔdB/20.

3.2.8 Shielding Recommendations

As mentioned in Par. 3.2.1 (g), the preliminary zero adjustment is required when the instrument is to be used on the three lowest ranges or when first setting up. Difficulty may be experienced in zeroing if the instrument is subjected to strong noise fields, making it necessary to shield the input to the Power Detector for this adjustment.

The simplest method of shielding the Detector is to connect it to the device being used, making sure that the device is first turned off. Occasionally, however, the device itself will act as an antenna and actually introduce the noise voltage into the Detector. Should this be the case, stand the Detector 'on its nose' on a copper plate, holding it down firmly so that the rim of the connector body is in good contact with the copper at all points. An alternative is to wrap a piece of thin copper foil around the barrel of the connector body, and crimp or fold it around the open end of the connector. (Do not short the center pin, however.) If this will be a frequent occurance, an adapter can be made up with a mating Type N connector permanently fitted with a copper-foil shield.

3.2.9 External Programming

External range control can be accomplished by simply grounding the appropriate pin on the edge connector (after grounding the MAN DISABLE pin). Programming can also be done with standard TTL logic-level inputs; logic-level 0 (< 0.7 volts) enables a range, and logic level 1 (2.4 to 5.25 volts) disables it.

3.2.10 DC Output

The dc output voltage at the rear terminals of the 42B is proportional to the input power. As the relationship of the meter indication to the output voltage is not linear, because of the action of the meter-shaping circuits, it will be necessary to refer to the correction chart of Figure 5. This chart is also reproduced on the top cover of the 42B case. Option -19 provides a dc output that is linear with power. Option -18 has a dc output linear with dBm.

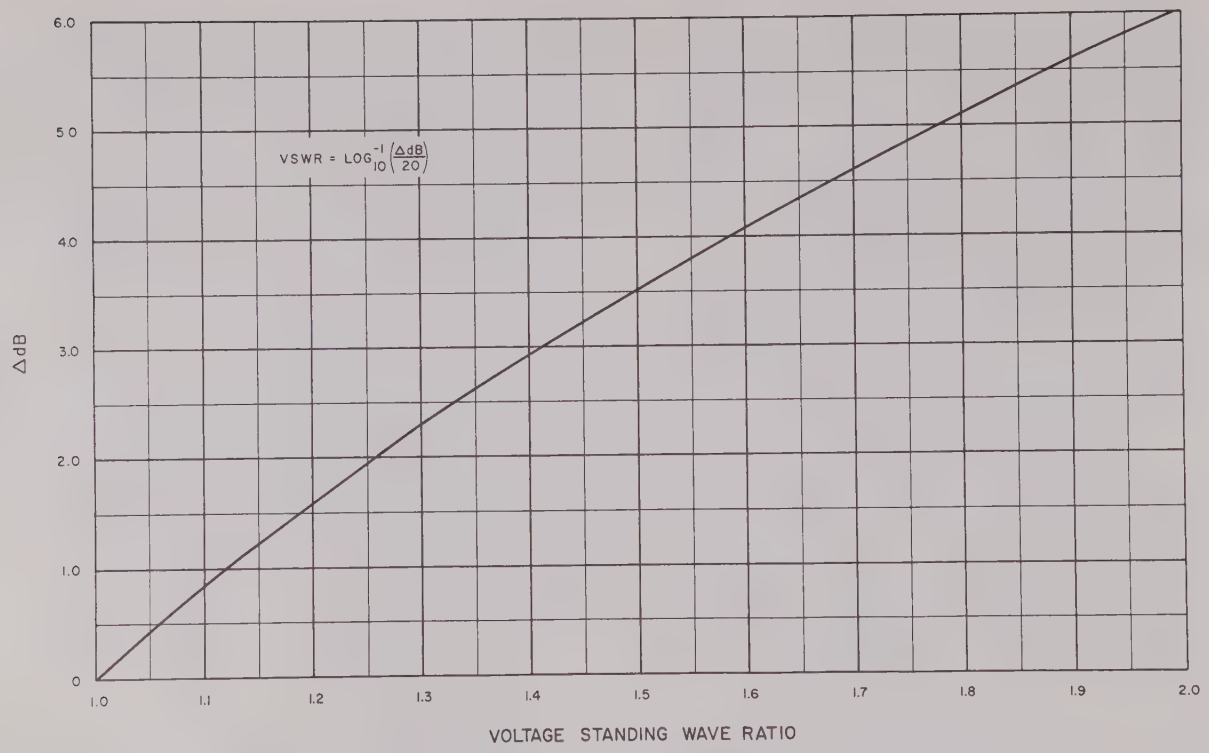


Figure 4. dB/VSWR Conversion Chart

BOONTON ELECTRONICS MICROWATTMETER MODEL 42B SER NO

POWER DETECTORS AND FREQUENCY RANGES

MODEL 41-4B: 50Ω, 0.2 MHz TO 12.4 GHz
MODEL 41-4A: 50Ω, 0.2 MHz TO 7 GHz
MODEL 41-4C: 75Ω, 0.2 MHz TO 1 GHz

ACCURACY

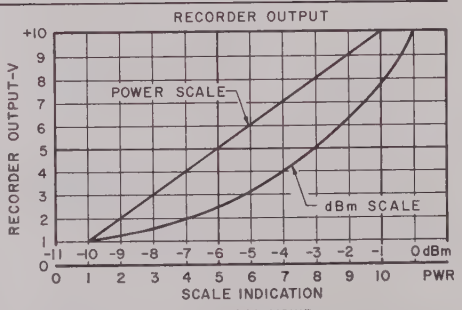
	0.1 μW TO 10 mW RANGE			10 nW RANGE		
	0.5% f.s. plus			1% f.s. plus		
	0.2 dB	0.3 dB	0.4 dB	0.4 dB	0.5 dB	0.6 dB
WITH 41-4B DET:	0.2MHz 4GHz	8.2GHz	12.4GHz	0.2 MHz 4GHz	8.2GHz	12.4GHz
WITH 41-4A DET:	0.2MHz 4 GHz	7GHz		0.2MHz 4GHz	7GHz	

OPERATION

WARM-UP PERIOD 1 MIN.; ADJUST ZERO ON 10nW RANGE WHEN MEASURING BELOW 1μW (-30dBm)

TEMPERATURE INFLUENCES

TEMPERATURE RANGE	INSTRUMENT	DETECTOR
REFERENCE 21°C TO 25°C	0	0
NORMAL 18°C TO 30°C	0	0.1 dB
SEVERE 10°C TO 40°C	0.2 dB	0.2 dB



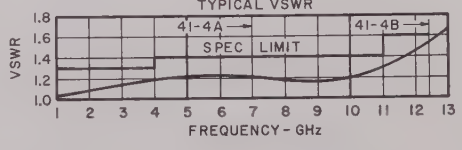


Figure 5. DC Output Correction Curve

Chapter IV
Circuit Description

4.1 GENERAL

The basic elements of the Model 42B are shown in the block diagram, Figure 6. The major components are the power detector, chopper, chopper driver, attenuator, preamplifier, amplifier, pulse generator, synchronous detector, shaping amplifier, power supply, meter shaping circuits, and the meter.

4.1.1 Power Detector

The power detector unit contains a non-inductive load resistor of 50 ohms, and a pair of special diodes connected as a full-wave rectifier. The rf voltage appearing across the load resistors is rectified by these diodes, producing a dc voltage whose level is a function of the input power level. When operation is in the square-law region (below approximately 15 microwatts), the detector provides true rms response. Above this power level the response gradually approaches peak-to-peak, calibrated on the meter scale in microwatts and dBm. The use of full-wave rectification permits the measurement of highly asymmetrical wave forms without substantial errors.

The special diodes used in the power detector have been carefully selected for specific characteristics; the user is urged not to attempt their replacement before reading section 5.7.4.

4.1.2 Attenuator and Amplifiers

The dc output voltage of the Power Detector is converted to ac by the mechanical chopper. This ac signal is applied to the attenuator and amplifier sections. For each range the output voltage from the second amplifier is approximately 3 volts peak-to-peak; this is done by ranging both the attenuation and the gain of the second amplifier.

The preamplifier has a constant gain of X100, and is designed for very low noise. Both amplifiers have moderately wide bandwidths, and are stabilized by large amounts of negative feedback.

4.1.3 Synchronous Detector

The amplified ac signal from the second amplifier is converted to dc by the synchronous detector; this is driven by pulses generated in the chopper-driver circuit, assuring exact synchronization. The peak-to-peak amplitude is derived from a shunt-series capacitor storage circuit, using JFET switches.

The characteristics of the detector determine the effective bandwidth of the amplifier-detector combination, and allow modification of the bandwidth for different range conditions. The detector also provides conversion without offset, with excellent linearity.

4.1.4 Shaping Amplifier

The conversion of rf to dc in the power detector is non-linear, the response being virtually square-law for the lowest ranges, and gradually becoming quasi-linear for the 10 mW range. The shaping amplifier converts the non-linear output of the detector to a linear output by using a segmental approximation to the exact correction. The shaping amplifier is actually an operational amplifier so connected that, as the signal increases at its output, its gain is reduced by successively paralleling resistors across the feedback resistors. The number of segments required adequately to linearize the response varies from 0 for the "square-law" ranges up to 5 for the 10 mW range. The output of the shaping amplifier is +10 volts full scale, which drives the panel meter and is also applied to the RECORDER terminals through a 9 kΩ resistor.

4.1.5 Chopper Driver

The chopper driving voltage is obtained by dividing the output of a unijunction oscillator by two. The same oscillator also generates the switching pulse for the synchronous detector; diode gating feeds the pulse to the proper JFET, depending upon the chopper phase.

4.1.6 Power Supply

The power supply converts the ac input power to regulated +15 V and -15 V outputs. Each supply is protected by current limiting against accidental short circuits. Both supplies are adjustable to 15.0 +0.1 V.

4.1.7 Programming

The instrument is organized around a seven-line ranging system. In each functional subcircuit the switching is done with solid-state devices, generally J FETs, which are actuated by the appropriate range line. The front panel range switches connect to the seven range lines to effect range selection. The range lines are also extended to the card-edge connector on the rear panel of the instrument, making them available for external programming. This may be done either by grounding the appropriate line and the manual disable terminal, of by applying a TTL Logic "0" (< 0.7) to the range line and the manual disable line.

It is recommended that an Amphenol 225-22221-101 connector, or equivalent, be used for making remote programming connections.

4.1.8 Meter Shaping

On a linear meter, the accuracy is specified as a percentage of the full-scale indication; this means that a reading near the bottom of the scale will exhibit an appreciable absolute error. The meter shaping circuits act to reduce this low-end error by effectively compressing the range of the meter swing; the low end of each of the instrument's ranges is thereby set to a point appreciably above the low end of the meter scale. By this means the overall accuracy is maintained at a high level.

4.1.9 Linear dBm Option

The Model 42B-18 Option instrument is equipped with an extra printed-circuit board containing a log converter circuit; this converts the linear power presentation of the standard instrument to a linear dB presentation from -10 dB to 0 dB (full scale). Below -10 dB (10% fs) the indication returns to linear power. The RECORDER output follows the meter presentation.

An additional RECORDER output mode is provided with a suppressed zero. The RECORDER output for full scale (0 dB) is +10.00 Vdc; for -10 dB the output drops to zero. The intermediate output is 1 dB/volt. The suppressed zero mode is selected by switching S801 to the 'down' position.

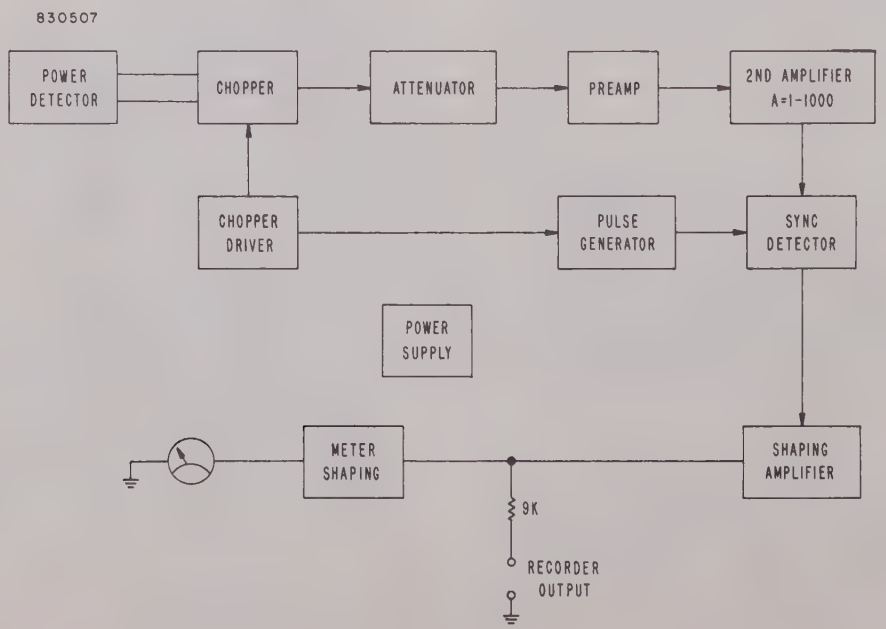


Figure 6. Block Diagram

5.1 PERIODIC CALIBRATION

The Model 42B is designed to provide trouble-free operation over extended periods of time. However, as with any precision instrument, a regular program of periodic calibration and operation checks should be followed to ensure continued good service. In the paragraphs that follow calibration procedures are detailed both for low-frequency and high-frequency calibration, as well as for normal trouble-shooting and repairs. It is well to remember that, when working with an instrument with the sensitivity and bandwidth of the 42B, it is essential that all precautions against stray pick-up be taken.

5.2 LOW-FREQUENCY CALIBRATION

Because of the outstanding low-frequency response of the Model 42B (200 kHz as compared to the usual 10 MHz of other instruments), it is convenient to check the calibration by using voltage sources in the frequency range of 200 kHz to 500 kHz. In this range there are commercial sources and reference standards available with the required accuracy. As the calibration procedure differs for the +10 dBm range compared to the other ranges, the procedures are given separately.

5.2.1 All Ranges Except +10 dBm

Suggested Equipment:

DC Source	HP 6218A
AC Source	HP 209A
Micropotentiometer	Ballantine Model 440 with 5 and 15 mA thermocouples and R = 140 mΩ, 1.4 Ω, and 14 Ω
DC Meter No. 1	HP Model 2402A Integrating DVM (pad for Z_{in} = 50Ω)
DC Meter No. 2	HP Model 419A DC Null Volt-Ammeter

(See Figure 7 for the test equipment interconnections needed for this test.)

Each range is checked by connecting the appropriate micropotentiometer (thermocouple and radial resistor) to the dc source and dc Meter No. 1, then adjusting the source until the dc Meter No. 1 reads the voltage equivalent to full-scale power for that range. (See Table 2 below) The reading of dc Meter No. 2 is then recorded. Now connect the micropotentiometer to the ac source and the Model 42 under test. Adjust the ac source until dc Meter No. 2 indicates the same value as recorded above. The rms output voltage of the micropotentiometer is now equivalent to the dc voltage previously read on the dc Meter No. 1. The Model 42 should now read full-scale, within the specified tolerance.

Table 2

Model 42 fs Range	Model 440 TC Resistor	Voltage to Model 42 Equiv. to dc Mtr. No. 1
-50 dBm	5 mA 140 mΩ	0.707 mV
-40	15 mA "	2.236
-30	5 1.4 Ω	7.071
-20	15 "	22.36
-10	5 14 Ω	70.71
0	15 "	223.6

5.2.2 +10 dBm Range

(See Figure 8 for the test equipment interconnections used for this test)

Suggested Equipment:

DC Source	HP 6218A
AC Source	HP 209A
DC Meter No. 1	HP Model 2402 Integrating DVM
DC Meter No. 2	HP Model 419A DC Null Volt-Ammeter
TVC	Ballantine 1393-1 Thermal Voltage Converter
Frequency Counter	Monsanto 100A

The +10 dBm range is checked by connecting the TVC to the dc source. The dc source is adjusted until dc Meter No. 1 reads 707 mV. The reading of dc Meter No. 2 is now recorded. Connect the TVC to the ac source tee. Adjust the ac source until dc Meter No. 2 reads the same value as that recorded above. The rms voltage now connected to the Model 42 will have a value equivalent to the 707 mV reading of dc Meter No. 1. The Model 42 should now read full-scale within the specified tolerance.

This completes the low-frequency calibration check procedure. If one or more ranges are out of the specified

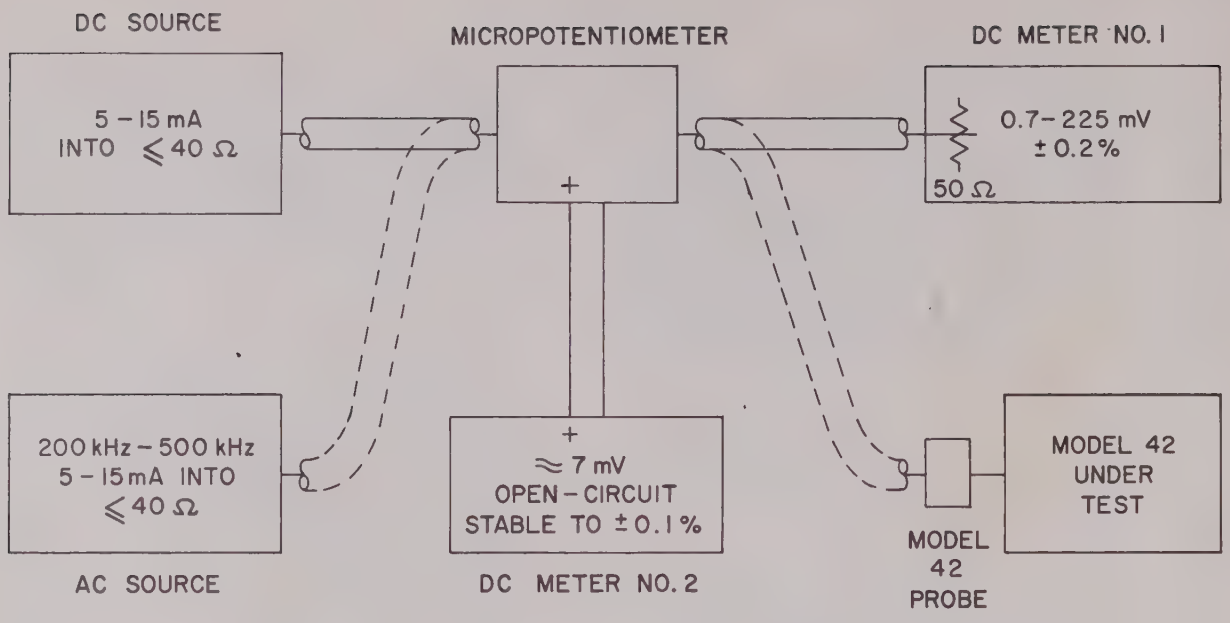


Figure 7.

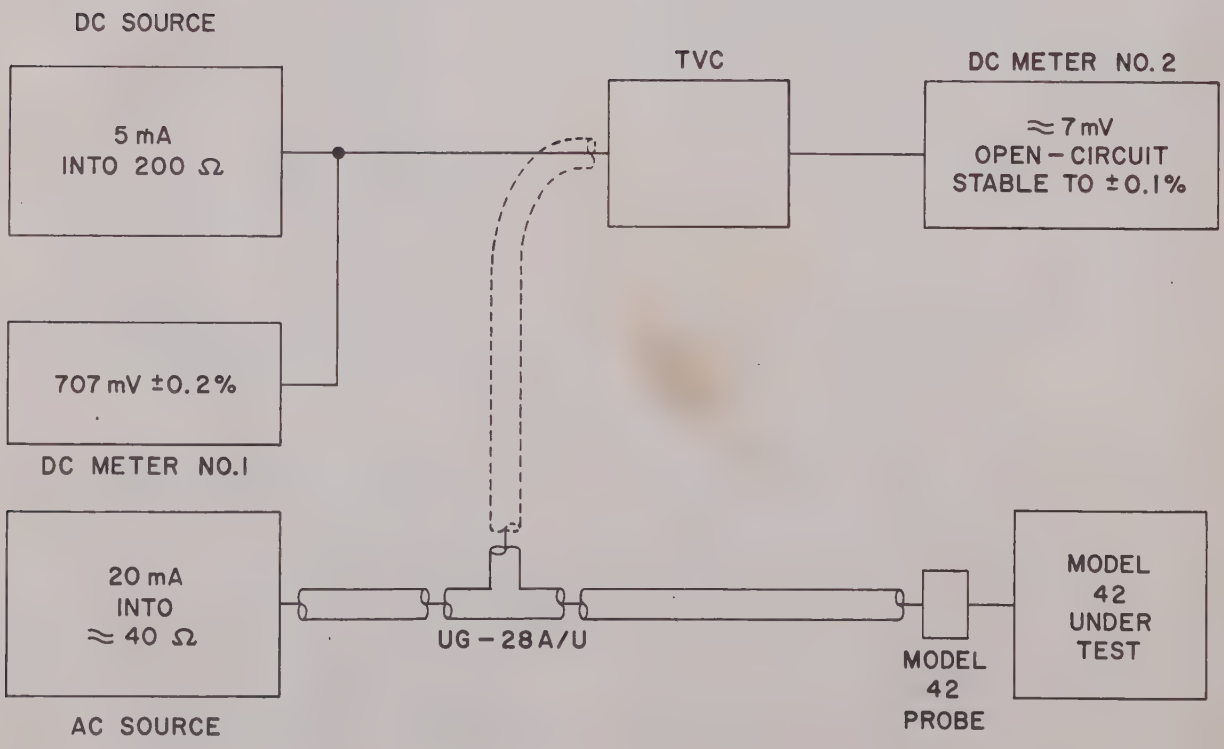


Figure 8.

tolerance, the calibration procedures of the following Section should be performed.

5.3 CALIBRATION PROCEDURE, 42B (See Section 5.4 for 42B-18)

The Model 42B should be turned on and allowed to warm up for several minutes before commencing any adjustments.

NOTE

Be sure that the CAL FACTOR control is set at 0. If the control knob has been removed from its shaft, perform Adjustment No. 18 first.

5.3.1 Calibration Procedure

Adjustment No. 1. Measure the -15.0 V supply voltage at the -15 V Test Point located on the Main Amplifier board at C119. Adjust R143 for a reading of -15.0 ±0.1 V.

Adjustment No. 2. Measure the +15.0 V supply voltage at the +15 V Test Point located on the Main Amplifier board at C118. Adjust R140 for a reading of +15.0 ±0.1 V.

Adjustment No. 3. Set the FULL SCALE range selector to the 1000 mV range, apply 7.07 mV input, and measure the chopper frequency at Test Point 13 on the Chopper-Driver board. Adjust R244 for a frequency of 94 ± 1 Hz (106.4 mS). Under some circumstances it may be desirable to offset the chopper frequency to avoid beating with a component of the ac power line frequency. Performance of the instrument will not be degraded by any offset within the range of the control.

Adjustment No. 4. Set the FULL SCALE range selector to the 10 nW range, and set the instrument with the front-panel ZERO control to an average zero indication.

Adjustment No. 5. Set the FULL SCALE range selector to the 1 μW range, and adjust R233 for a zero indication.

Adjustment No. 6. Set the FULL SCALE range selector to the 1 μW range. Zero the instrument as in Adjustment No. 4. Apply 7.071 mV ± 0.2% (8.66 mV)* and adjust R180 for a reading of -3.00 Vdc at Test Point 17 on the Chopper-Driver board.

Adjustment No. 7. Set the FULL SCALE range selector to the 1 μW range. Zero the instrument. Apply 7.071 mV (8.66 mV) ± 0.2%, and adjust R523 for an indication of +10.00 V at the RECORDER terminals.

Adjustment No. 8. Set the FULL SCALE range selector to the 1 μW range. Apply 7.071 mV (8.66 mV) ± 0.2% and adjust R408 for an indication of 1 μW.

Adjustment No. 9. Set the FULL SCALE range selector to the 10 nW range and zero the instrument. Apply 0.707 mV (0.866 mV) ± 0.2% input and adjust R525 for an indication of 10 nW.

Adjustment No. 10. Set the FULL SCALE range selector to the 100 nW range, zero the instrument, and apply 2.236 mV ±0.2% (2.738 mV). Adjust R524 for an indication of 100 nW.

Adjustment No. 11. Set the FULL SCALE range selector to the 10 μW range, apply 22.36 mV ±0.2% (27.38 mV), and adjust R522 for a 10 μW reading.

Adjustment No. 12. Set the FULL SCALE range selector to the 100 μW range, apply 70.71 ±0.2% (86.60 mV), and adjust R521 for a 100 μW reading.

Adjustment No. 13. Still on the 100 μW range, apply 22.36 mV ±0.2% (27.38 mV), and adjust R543 for a reading of 10 μW. Repeat Adjustment No. 12, then Adjustment No. 13 as required until stable readings are obtained.

Adjustment No. 14. Set the FULL SCALE range selector to the 1 mW range, apply 223.6 mV ±0.2% (273.8 mV), and adjust R520 for a 1 mW reading.

Adjustment No. 15. Still on the 1 mW range, apply 70.71 ±0.2% (86.60 mV), and adjust R548 for a reading of 100 μW. Repeat Adjustments 14 and 15 until a stable reading is obtained.

*Values in parenthesis apply to the 41-46 (75Ω) Power Detector.

Adjustment No. 16. Set the FULL SCALE range selector to the 10 mW range and apply 707.1 ±0.2% (866.0 mV). Adjust R519 for a reading of 10 mW.

Adjustment No. 17. Still on the 10 mW range, apply 223.6 mV ±0.2% (273.8 mV), and adjust R562 for a reading of 1 mW.

Adjustment No. 18. (Calibration Factor Adjustment) This adjustment will only be required if the control knob has been removed from its shaft. Adjust the position of the knob on the shaft so that the pointer is equally centered between the two end points of the scale (-1 and +1 dBm). (The mechanical end stops are slightly past the marked end points.)

Set the FULL SCALE range selector to the 1 μW range, set the CAL FACTOR control on -1.0 dBm, and adjust the input level to 0.631 μW (-32 dBm). Turn the CAL FACTOR control to the +1.0 dBm mark and adjust R573 for a reading of 1.00 μW (-30 dBm).

5.4 CALIBRATION PROCEDURE, MODEL 42B-18

NOTE: Adjustments No. 5 and 19 through 26 must be done before making Adjustments 1 through 18 in the preceeding section.

After allowing the instrument to warm up for several minutes, set the CAL FACTOR control to 0 and make the following adjustments:

5.4.1 Calibration Procedure

Adjustment No. 5. Set the FULL SCALE range selector to the 1 μW range, and adjust R233 for a zero reading at TP5 on the Log Converter board. Note: See that the switch S801 on the Log Converter board is open (up position).

Adjustment No. 19. Set the FULL SCALE range selector to the 1 μW range and adjust R816 for a zero meter indication.

Adjustment No. 20. Set the FULL SCALE range selector to the 1 μW range, and adjust the rf input for a reading of +2.000 ±0.002 Vdc at TP5. Adjust R816 for -0.301 Vdc at TP1.

Adjustment No. 21. Set the FULL SCALE range selector to the 1 μW range and adjust the rf input for +10.00 ±0.01 Vdc at TP5. Adjust R807 for -1.00 Vdc at TP2.

Adjustment No. 22. Set the FULL SCALE range selector to the 1 μW range and adjust the rf input for 0.000 Vdc at TP5. Adjust R804 for +1.00 Vdc at TP2.

Adjustment No. 23. Set the FULL SCALE range selector to the 1 μW range and adjust the rf input for +1.000 ±0.001 Vdc at TP5. Adjust R812 for +1.00 Vdc at TP3.

Adjustment No. 24. Set the FULL SCALE range selector to the 1 μW position and adjust the rf input for +10.00 ±0.01 Vdc at TP5. Adjust R806 for +10.00 Vdc at TP3.

Adjustment No. 25. Set the FULL SCALE range selector to the 1 μW range and adjust the rf input for +10.00 ±0.01 Vdc at TP5. Adjust R820 for a meter indication of 1.00 μW.

Adjustment No. 26. Set the FULL SCALE range selector to the 1 μW position, and switch S801 to the down position (on). Adjust the rf input for a +1.000 ±0.001 Vdc at TP5. Adjust R822 for 0.000 Vdc at TP4. Return S801 to the up position, and repeat Adjustments 24 and 25.

At this point, perform Adjustments 1 through 18 in Section 5.3. This completes the calibration of the 42B-18.

5.5 CALIBRATION PROCEDURE, MODEL 42B-19.

5.5.1 Perform Adjustments 1 through 18 of the 42B procedure, Section 5.3, substituting Adjustment No. 27 for Adjustment No. 8.

Adjustment No. 27. Set the FULL SCALE range selector to the 1 μW range position. Apply 7.071 mV (8.66 mV) ±0.2% to the input and adjust R182 for a meter indication of 1.00 μW.

5.6 TROUBLE-SHOOTING PROCEDURE

If faulty operation of the Model 42B is evident, or if the calibration procedure in the preceeding sections fails to correct an inaccurate reading, the following steps will help to isolate and correct the fault.

5.6.1 Chopper Replacement

The mechanical chopper used in the 42 is a possible source of difficulty. The simplest way to check this part is to replace it temporarily with a new one. Note that the chopper is a special Boonton Electronics part; a spare or replacement can be obtained from your local BEC representative or directly from the factory.

If the new chopper clears up the trouble, the instrument should be recalibrated before attempting to use it. If the trouble remains, remove the new chopper and replace with the old one.

5.6.2 Voltage and Resistance Tests

After eliminating the chopper as the source of trouble, a systematic check of the ac and dc voltages, resistances, and wave forms should be made. The schematic drawings in the back fo this manual show the test points available, together with the voltage levels and wave forms that should be found at these points. The symptoms observed during calibration should help to narrow down the faulty component or circuit.

5.6.3 Power Detector Replacement

If a second Power Detector is available, it may be used to replace the one supplied with the instrument for a quick check. Each Power Detector is calibrated with the instrument with which it will be used; should a replacement Detector be necessary, the instrument must be recalibrated with the new Detector to avoid errors in measurement accuracy.

If this check shows that the Power Detector is at fault, it is recommended that it be returned to the factory for repair. While the Power Detector can be repaired by the user, the adjustment is a difficult operation requiring a high degree of skill and knowledge. Section 5.7.4 details the repair and adjustment procedure necessary.

5.7 HIGH FREQUENCY CALIBRATION

After following the procedures outlined in Sections 5.2 through 5.6, as required, the Model 42B is now checked and calibrated to be within the specified accuracy for low-frequency power measurements. The performance of the 42 at high frequencies is described in terms of corrections called Calibration Factor and Effective Efficiency. The following sections define these terms, explain their use, and describe the calibration procedures required for their determination.

5.7.1 Calibration Factor and Effective Efficiency

Power measurements are made on either a Z_o match or conjugate match basis. On a Z_o match basis the measured power is given by:

$$P_{meas} = \frac{(1 - e)K P_o}{|1 - \Gamma g \Gamma m|^2}$$

where P_{meas} = measured power
e = low frequency instrumentation error
Γg = complex generator reflection coefficient
Γm = complex power reflection coefficient
P_o = power that would be delivered to a perfect Z_o load
K = calibration factor

If the generator source impedance or power meter head provides a perfect Z_o match, the term $|1 - \Gamma g \Gamma m|^2$ is unity. In all other cases the complex reflection coefficients have to be measured for the most accurate measurements or the uncertainty of measurement inherent in this term has to be accepted. Figures 9 and 10 show this uncertainty expressed either in dB or % in terms of the source and load VSWR, recalling that $VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|}$. In addition to the uncertainty, the mismatch loss associated

Uncertainty - DB $\dfrac{1}{(1 \pm |\Gamma_G||\Gamma_L|)^2}$

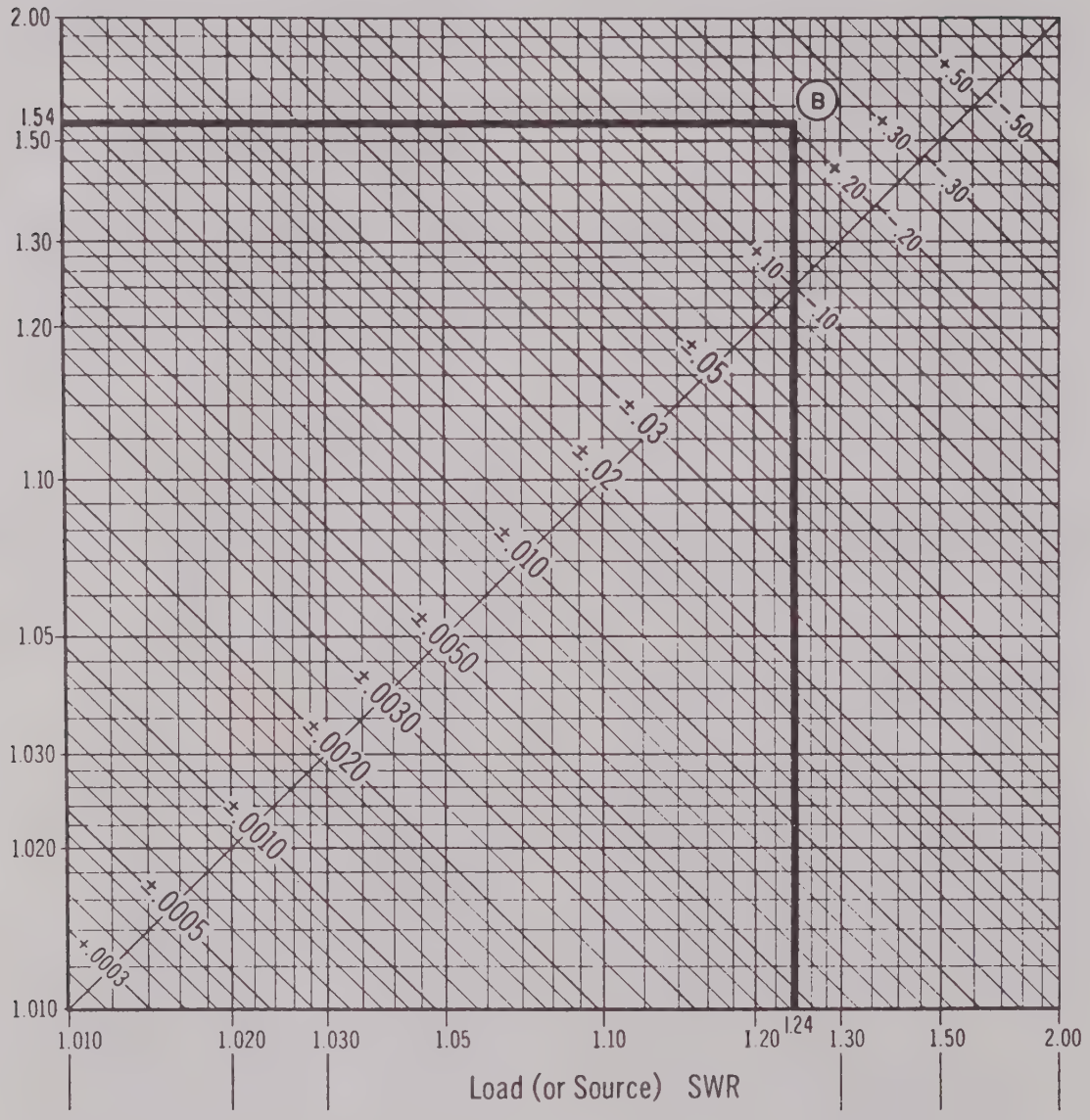


Figure 9.

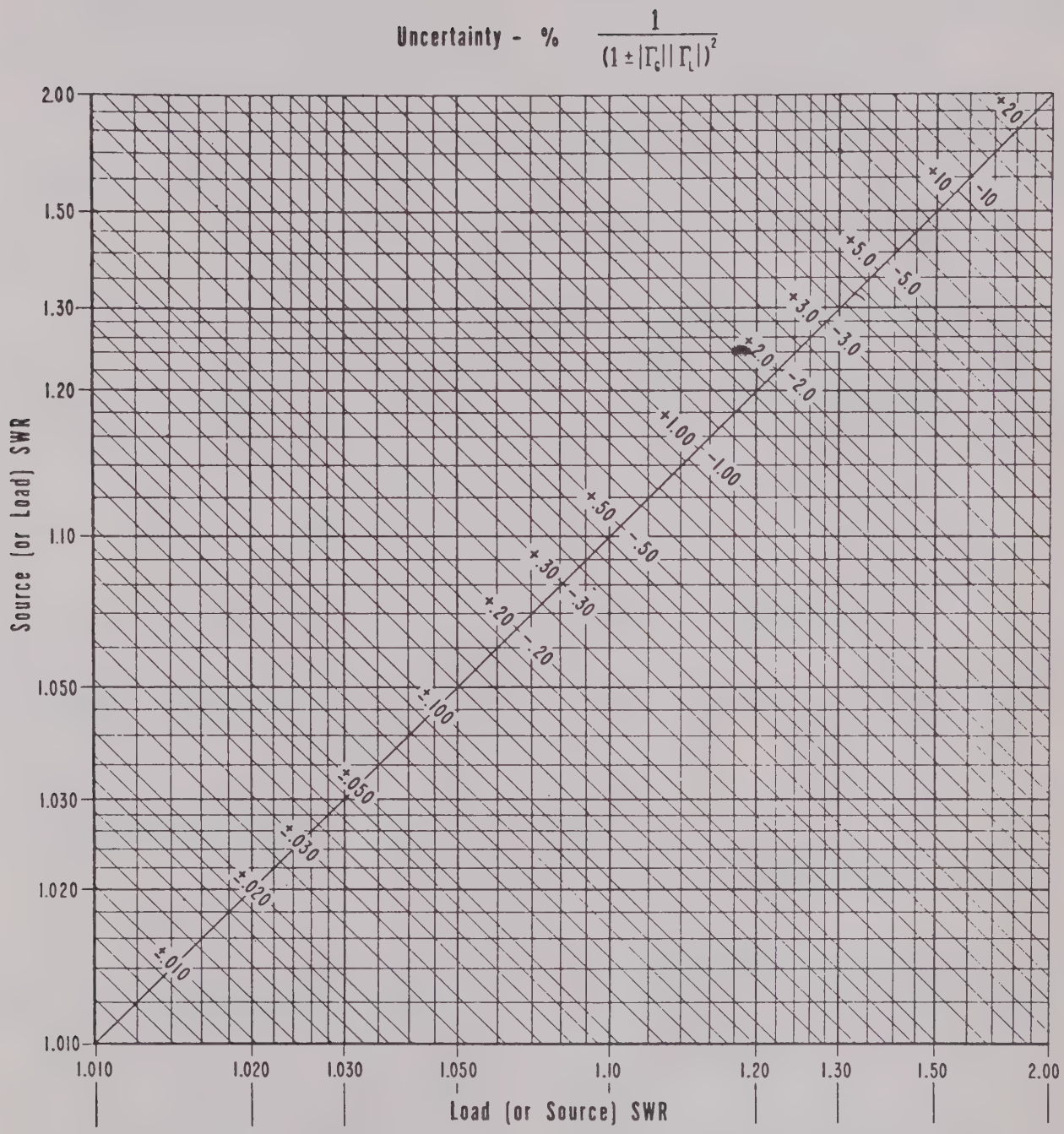

Uncertainty - % $\frac{1}{(1 \pm |\Gamma_s||\Gamma_l|)^2}$
Source (or Load) SWR
Load (or Source) SWR
2.00
1.50
1.30
1.20
1.10
1.050
1.030
1.020
1.010
1.010
1.020
1.030
1.050
1.10
1.20
1.30
1.50
2.00
±.010
±.020
±.030
±.050
±.100
±.20
±.30
±.50
±1.00
±2.0
±3.0
±5.0
±10
±20
-.20
-.30
-.50
-1.00
-2.0
-3.0
-5.0
-10

Figure 10.

with the power meter head is described by the calibration factor K_b where

$$K_b = \frac{\text{Indicated Power}}{\text{Incident Power}}$$

When power measurements are made on a conjugate match basis, the measured power is given by:

$$P_{meas} = (1 - e)K_T \eta P_c$$

where e = low frequency instrumentation error

K_T = tuner transmission characteristic

$$= \frac{\text{power delivered by tuner to load}}{\text{power delivered to tuner input}}$$

P_c = power that would be delivered to a perfect conjugate load

η = effective efficiency

The effective efficiency η is described by:

$$\eta = \frac{\text{Indicated Power}}{\text{Dissipated Power}}$$

The calibration factor and effective efficiency are related by the following equation:

$$K_b = (1 - |\Gamma m|^2)$$

where $|\Gamma m|$ is the absolute value of the power meter head reflection coefficient.

5.7.2 · Determination of Calibration Factor

Required equipment:

1. Standard Power Meter. This is any suitable instrument (BE 42, HP 432, Gen. Micro. 454, PRD 6685, Marda 443, etc.) whose power head has been certified for Calibration Factor K_s by standards traceable to NBS and whose low-frequency instrumentation error e_l is known.
2. Generator
3. Double-stub Tuner, Narda 903N
4. Directional Coupler, Weinschel Model 1538
5. Precision Termination, Weinschel Model 1404
6. 6 dB pad, Weinschel Model 1
7. Model 42 Power Meter (accuracy of calibration not important)
8. Model 42 to be calibrated
9. 50 Ω Termination, HP 909A

Connect the equipment as shown in Figure 11a

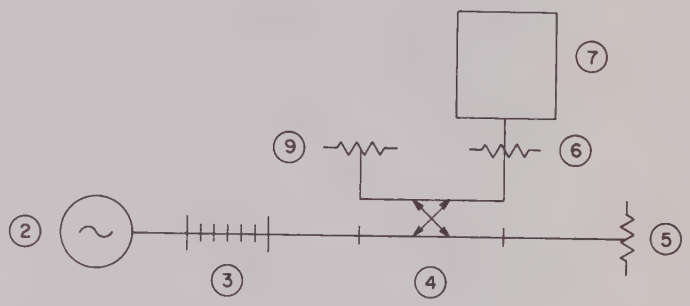


Figure 11a

1. Adjust the generator (2) to a convenient low frequency and a level sufficient for a stable reading on the Model 42 (7) .
2. Adjust the stub tuner (3) for a maximum indication on the Model 42 (7) .

Connect the equipment as shown in Figure 11b

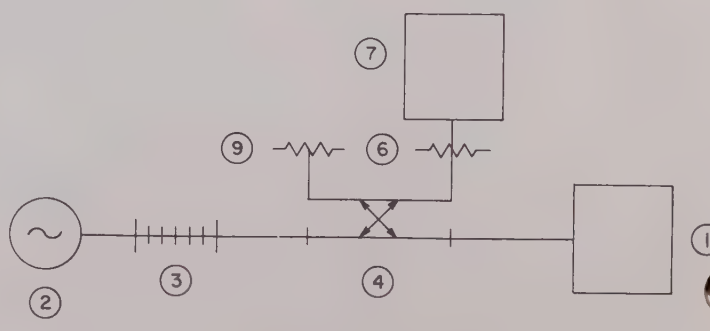


Figure 11b

3. At the same generator frequency as 1. above, adjust the generator level for a convenient level on the standard power meter (1) . Record the output of the Model 42 (7) . Record the indicated P_{ind_1} of the standard power meter (1) .

Connect the equipment as shown in Figure 11c.

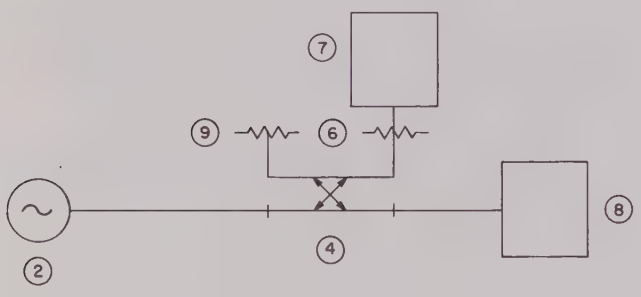


Figure 11c

4. At the same generator frequency at 1. and 3. above, adjust the generator level until the Model 42 (7) reads the value recorded in 3. above. Record the indicated power P_{ind_2} on the Model 42 to be calibrated (8) .

The calibration factor K of the Model 42 is now computed from the relationship:

$$K = K_s \frac{(1 - e_2) P_{ind_2}}{(1 - e_1) P_{ind_1}}$$

where K_s = calibration factor of standard power meter

e_1 = instrumentation error of standard power meter for the range used

P_{ind_1} = indicated power on standard power meter

e_2 = instrumentation error of Model 42 for the range used as determined in 5.4.

P_{ind_2} = indicated power of Model 42

NOTE: It is important that the instrumentation error e_1, of the standard power meter be known completely. For bolometer and thermocouple-type power meters, this error can usually be determined by dc substitution methods, as described by the manufacturers. In most cases, the uncertainty of instrumentation error can be improved by operating at higher power levels.

At all other frequencies of interest, repeat the steps 1. through 4.

5.7.3 Determination of Effective Efficiency

Required equipment:

1. Generator
2. Directional Coupler, Weinschel Model 1538
3. 2 - 6 dB pads, Weinschel Model 1
4. 2 Model 42 Power Meters
5. Model 42 to be calibrated whose Calibration Factor has been determined according to section 5.5.2.

Connect the equipment as shown in Figure 12.

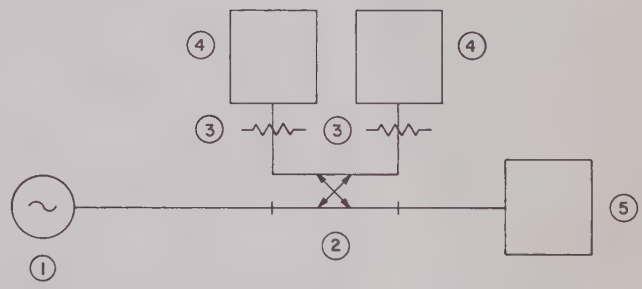


Figure 12

1. Set the generator to the first frequency of interest and increase its level for a convenient reading of the Model 52 (5) to be calibrated.

2. Measure the incident and reflected power on the two Model 42's and record these values as $P_{incident}$ and $P_{reflected}$. In recording these values, correct the meter readings for the two 6 dB pads (3) .

3. Calculate the magnitude of the reflection coefficient $|\Gamma m|$ of the Model 42 to be calibrated according to:

$$|\Gamma m| = \sqrt{\frac{P_{reflected}}{P_{incident}}}$$

The effective efficiency η is now given by:

$$\eta = \frac{K}{1 - |\Gamma_m|^2}$$

where K is the calibration factor as determined in section 5.6.2.

At all other frequencies of interest, repeat steps 1 through 3.

This completes the high frequency power calibration of the Model 42.

5.8 POWER DETECTOR REPAIR

NOTE

Repair and adjustment of a Power Detector is a difficult operation requiring a high degree of knowledge and skill. If the user elects to make such a repair, rather than to return the Detector to this factory, it must be understood that the repaired Detector may not meet the vswr and response characteristics as specified in this manual.

Before attempting a repair of the Power Detector, check all possible sources of trouble, such as the instrument itself, the probe cable, connectors, the RF power source, etc. If the defect cannot be located, and the symptoms indicate a faulty Power Detector, make the external resistance measurements outlined below to localize the trouble before opening the Detector housing. (A Simpson Model 260 is recommended for most of these measurements.)

a. Measure the resistance of the RF input connector from the center conductor to ground shell. This should be 50 ± 1 ohms. (For this measurement, a more accurate instrument than the Model 260 must be used.)

b. Inspect the rear connector for possible damage. Measure the resistance from pins 1 and 2 to ground. This should measure > 10 MΩ.

c. With the Model 260 on the 10 kΩ range, measure the resistance from pin 1 (negative lead of the 260) to pin 2 (positive lead). This should be 20 to 30 kΩ.

d. With the Model 260 on the 10 kΩ range, measure the resistance from pin 1 (positive lead of the 260) to pin 2 (negative lead). This should be >400 kΩ.

After completing the resistance measurements, the Power Detector housing may be opened as follows:

e. Remove the three 2-56 screws holding the outer shield. Slide the shield forward over the RF input connector.

f. Look for broken wires at this point. If any are found, repair them and retest the unit before proceeding.

g. The rear connector may now be replaced, if necessary, by removing the set-screw at the side of the rear disc (the red mark on the side of the housing polarizes pin 1).

h. Remove the four 2-56 screws holding the inner shield. Slide the shield backwards from the main housing. Unsolder the wires at the teflon terminals, if necessary.

If the Power Detector failed the insulation test in (b), look for a short to ground from the 1000 pF capacitors C102 and C103, or an internal short in one of the capacitors. These capacitors may be removed by taking out the two 0-80 screws on the side of the bracket. Tilt the housing to the side so the bracket will fall away when a soldering iron is touched to the joint. The capacitor may then easily be replaced remotely from the housing. Screw the bracket to the housing before soldering.

CAUTION

Always ground the soldering iron tip when soldering the probe housing to avoid damaging the diodes.

If the Power Detector failed the tests of (c) or (d), measure the resistance of the diodes CR101 and CR102 with the Model 260 on the 10 kΩ range. The forward resistance of each diode should measure about 500 ohms, and the backward resistance should be greater than 50 kΩ. If the back resistance of a diode measures appreciably less than 50 kΩ, replace it, using the following technique:

i. While grasping the diode with tweezers, and applying a light upward pull, touch the center post with a small, high-temperature iron. The diode will lift when the solder melts. Now unsolder the far end of the series resistor and lift out the diode-resistor combination.

j. At this point, test the terminating resistors as in (a). If R101 or R102 tests faulty, replace it as follows:

   Remove the four 2-56 screws holding the 100 Ω resistors in place. Unsolder from the center post by pulling the resistor from the rear while heating the center post. (Overheating can cause distortion of the teflon spacer supporting the center conductor.) Replace the new resistor in the reverse order.

k. Replace the diode/resistor networks by soldering the resistor ends first, and then touching the center post as quickly as possible with the iron to solder the diode lead.

After any critical parts (diodes or terminating resistors) have been replaced, it will be necessary to check the input vswr throughout the specified frequency range. The test may be made with the shields off to make adjustment easier. The vswr may be checked by any convenient means, such as slotted line, reflectometer, etc. Adjust the length of the 100 Ω resistor leads with the clamps on the top of the housing. In general, longer lead lengths will increase the vswr at 6 and 7 GHz, and will decrease it at 11 and 12 GHz. It will usually be necessary to compromise somewhat in these adjustments and try to find an optimum setting across the range.

Variations in the high-frequency response after repair are covered by the Calibration Factor and Effective Efficiency sections of this manual, found in Paragraphs 5.7.2 and 5.7.3 respectively.

If proper adjustment of the Power Detector after repair is found difficult, return it to the factory. In a covering letter, be sure to include details of all work performed on the Detector and parts replaced. This information will help our repair department to return the Detector to you in the shortest possible time.

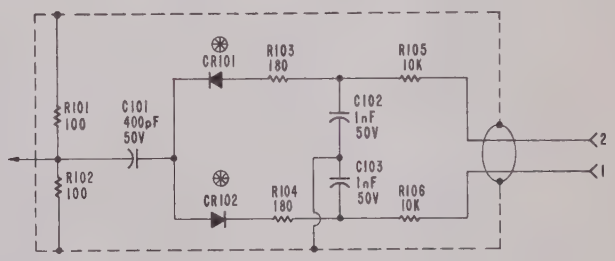


Figure 13. Power Detector

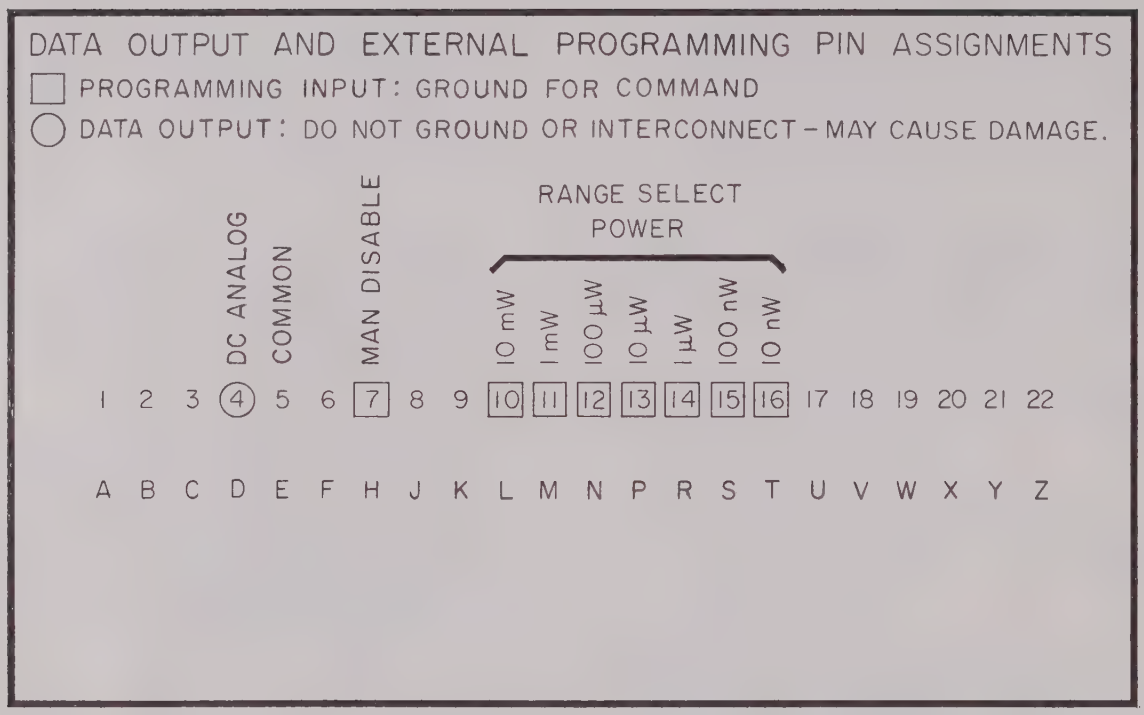

DATA OUTPUT AND EXTERNAL PROGRAMMING PIN ASSIGNMENTS
PROGRAMMING INPUT: GROUND FOR COMMAND
DATA OUTPUT: DO NOT GROUND OR INTERCONNECT - MAY CAUSE DAMAGE.
DC ANALOG COMMON
MAN DISABLE
RANGE SELECT POWER
10 mW
1 mW
100 µW
10 µW
1 µW
100 nW
10 nW
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
A B C D E F H J K L M N P R S T U V W X Y Z

Figure 14. External Connections.

Reference		Description	BEC Part No.
C101	Capacitor, PE	100 nF 10% 200 V	234005
C102	" , EL	10 µF 20% 20 V	283205
C103	" , Mica	100 pF 5% 500 V	200001
C104	" , EL	10 µF 20% 20 V	283205
C105	" , Elect.	33 µF 20% 15 V	283206
C106	" , EL	10 µF 20% 20 V	283205
C107	" , MET	1.0 µF 20% 100 V	236007
C108	" , EL	1.0 µF 20% 35 V	283199
C109	" "	50 µF 25 V	283159
C110	" "	"	"
C111	" , PE	100 nF 10% 200 V	234005
C112	" , EL	250 µF 40 V	283207
C113	" "	"	"
C114			
C115	" , CER	100 nF +80% -20% 25 V	224124
C116	" "	"	"
C117			
C118	" , EL	100 µF 20% 25 V	283105
C119	" "	"	"
C201	Capacitor, PC	100 nF 10% 50 V	234046
C202	" "	6.8 nF 10% 200 V	234044
C203	Capacitor, MIC	100 pF 5% 500 V	200001
C204	" "	"	"
C205	" , PE	22 nF 10% 200 V	230101
C206	" , PC	100 nF 10% 50 V	234046
C207	" , MIC	100 pF 5% 500 V	200001
C208	" , PC	100 nF 10% 50 V	234046
C209	" , CER	10 nF Disc 100 V	224119
C210	" "	"	"
C211	" , PE	18 nF 5% 200 V	234064
C212	" , PC	220 nF 10% 50 V	234075
C213	" , MIC	100 pF 5% 500 V	200001
C214	" , EL	50 µF 25 V	283159
C215	" "	"	"
C216	" "	"	"
C217	" "	150 µF -10% +75% 15 V	283307
C401	Capacitor, MYL	100 nF 10% 50 V	234046
C402	" "	"	"
C501	Capacitor, CER	10 nF 100 V	224119
C502	" "	33 pF 5% 500 V	224139
C503	" "	10 nF 100 V	224119
C504	" "	"	"
C505	" "	33 pF 5% 500 V	224139
C506	" "	10 nF 100 V	224119
* C801	Capacitor, Cer.	0.01 µF 100 V	244119
* C802	" , Mic.	300 pF 5% 500 V	200034
* C803	" "	"	"
* C804	" , Cer.	0.01 µF 100 V	244119
* C805	" "	"	"
* C806	" , Mic.	20 pF 5% 500 V	200027
* C807	" "	150 pF 5% 500 V	200032
* C808	" , Cer.	0.01 µF 100 V	224119
* C809	" "	33 pF 5% 500 V	224139
* C810	" "	0.01 µF 100 V	224119
* C811	" "	33 pF 5% 500 V	224139
* C812	" "	0.01 µF 100 V	224119

*For Model 42B-18 only.

Reference		Description	BEC Part No.
R101	Resistor, Comp.	1 MΩ 5% 1/2W	301159
R102	" "	3.9 kΩ 5% 1/4W	300096
R103	" "	"	"
R104	" , MF	5.62 MΩ 1% 1/4W	325397
R105			
R106	" , MF	52.3 kΩ 1% 3/8W	340445
R107	" "	232 kΩ 1% 3/8W	340522
R108	" "	1.0 MΩ 1% 3/8W	325700
R109			
R110	" , Comp.	91 kΩ 5% 1/2W	301134
R111	" "	47 kΩ 5% 1/2W	301127
R112	" "	33 kΩ 5% 1/2W	301123
R113	" "	300 kΩ 5% 1/2W	301146
R114	" , MF	121 Ω 1% 3/8W	340129
R115	" , Comp.	10 kΩ 5% 1/2W	301111
R116	" "	"	"
R117	" "	33 kΩ 5% 1/2W	301123
R118	" , MF	15.0 kΩ 1% 3/8W	340378
R119	" , Comp.	15 kΩ 5% 1/2W	301115
R120	" "	3.6 kΩ 5% 1/2W	301100
R121	" "	3 kΩ 5% 1/2W	301098
R122	" "	1 MΩ 5% 1/2W	301159
R123	" "	2.7 kΩ 5% 1/2W	301097
R124	" "	5.6 kΩ 5% 1/2W	301105
R125	" "	"	"
R126	" "	1 kΩ 5% 1/2W	301087
R127	" "	5.1 kΩ 5% 1/2W	301104
R128	" "	15 kΩ 5% 1/2W	301115
R129	" "	1 kΩ 5% 1/2W	301087
R130	" "	10 kΩ 5% 1/2W	301111
R131	" , MF	30.1 kΩ 1% 3/8W	326397
R132	" "	3.01 kΩ 1% 3/8W	340297
R133	" "	301 Ω 1% 3/8W	340176
R134	" "	34.8 Ω 1% 3/8W	340065
R135	" , Comp.	1 MΩ 5% 1/2W	301159
R136	" "	1 kΩ 5% 1/2W	301087
R137	" "	"	"
R138	" "	15 kΩ 5% 1/2W	301115
R139	" , MF	1.62 kΩ 1% 3/8W	340267
R140	" , Var.	200 Ω 10% 1/2W	311304
R141	" , MF	604 Ω 1% 3/8W	340213
R142	" "	1.62 kΩ 1% 3/8W	340267
R143	" , Var.	200 Ω 10% 1/2W	311304
R144	" , MF	604 Ω 1% 3/8W	340213
*R145	" "	9.09 kΩ 1% 3/8W	340354
R148	Resistor, Comp.	100 kΩ 5% 1/4W	300130
R149	" "	160 kΩ 5% 1/4W	300135
R150	" "	39 kΩ 5% 1/4W	300120
R151	" "	100 kΩ 5% 1/4W	300130
R158	" "	160 kΩ 5% 1/4W	300135
R159	" "	39 kΩ 5% 1/4W	300120
R160	" "	100 kΩ 5% 1/4W	300130
R161	" "	160 kΩ 5% 1/4W	300135
R162	" "	39 kΩ 5% 1/4W	300120
R163	" "	100 kΩ 5% 1/4W	300130
R164	" "	160 kΩ 5% 1/4W	300135
R165	" "	39 kΩ 5% 1/4W	300120
R166	" "	100 kΩ 5% 1/4W	300130
R167	" "	160 kΩ 5% 1/4W	300135
R168	" "	39 kΩ 5% 1/4W	300120
R169	" "	100 kΩ 5% 1/4W	300130
R170	" "	160 kΩ 5% 1/4W	300135
R171	" "	39 kΩ 5% 1/4W	300120
R172	" "	100 kΩ 5% 1/4W	300130
R173	" "	160 kΩ 5% 1/4W	300135

Reference		Description	BEC Part No.
R174	" "	39 kΩ 5% 1/4W	300120
R175	" "	100 kΩ 5% 1/4W	300130
R176	" "	160 kΩ 5% 1/4W	300135
R177	" "	39 kΩ 5% 1/4W	300120
R178	" "	100 kΩ 5% 1/4W	300130
R179	" , MF	150 Ω 1% 3/8W	340141
R180	" , Var.	100 Ω 20%	311258
** R181	" , MF	46.4 kΩ 1% 3/8W	340438
** R182	" , Var.	10 kΩ 10% 1/2W	311328

*Delete for Models 42B-18 and 42B-19.
**Used in Model 42B-19 only.

R201	Resistor, Comp.	10 kΩ 5% 1/2W	301111
R202	" "	27 kΩ 5% 1/2W	301121
R203	" "	10 kΩ 5% 1/2W	301111
R204	" "	100 Ω 5% 1/2W	301063
R205	" "	33 kΩ 5% 1/2W	301123
R206	" "	10 kΩ 5% 1/2W	301111
R207	" "	100 kΩ 5% 1/2W	301135
R208	" "	3.3 kΩ 5% 1/2W	301099
R209	" "	4.7 kΩ 5% 1/2W	301103
R210	" "	10 kΩ 5% 1/2W	301111
R211	" "	150 kΩ 5% 1/2W	301139
R212	" "	10 kΩ 5% 1/2W	301111
R213	" "	"	"
R214	" "	22 kΩ 5% 1/2W	301119
R215	" "	10 kΩ 5% 1/2W	301111
R216	" "	270 kΩ 5% 1/2W	301145
R217	" "	240 kΩ 5% 1/2W	301144
R218	" "	10 kΩ 5% 1/2W	301111
R219	" "	15 kΩ 5% 1/2W	301115
R220	" "	10 kΩ 5% 1/2W	301111
R221	" "	"	"
R222	" "	12 kΩ 5% 1/2W	301113
R223	" "	4.7 kΩ 5% 1/2W	301103
R224	" "	12 kΩ 5% 1/2W	301113
R225	" "	100 kΩ 5% 1/2W	301135
R226	" "	"	"
R227	" "	15 kΩ 5% 1/2W	301115
R228	" "	10 kΩ 5% 1/2W	301111
R229	" "	100 kΩ 5% 1/2W	301135
R230	" "	12 kΩ 5% 1/2W	301113
R231	" "	4.7 kΩ 5% 1/2W	301103
R232	" "	100 kΩ 5% 1/2W	301135
R233	" , Var.	2 kΩ 20% 1/2W	311285
R234	" , Comp.	100 kΩ 5% 1/2W	301135
R235	" "	"	"
R236	"	27 kΩ 5% 1/2W	301121
R237	" "	100 kΩ 5% 1/2W	301135
R238	" "	"	"
R239	" "	1.6 kΩ 5% 1/2W	301092
R240	" "	300 Ω 5% 1/2W	301074
R241	" "	62 Ω 5% 1W	302072
R242	" "	150 kΩ 5% 1/2W	301139
R243	" "	510 kΩ 5% 1/2W	301152
R244	Resistor, Var.	20 kΩ 20% 1/2W	311330
R245	" , Comp.	47 Ω 5% 1/2W	301055

Reference	Description	BEC Part No.
R401	Resistor, Var. 5 kΩ 20% 2W	311255
R402	" " 5 kΩ 10% 2W	311265
R403	" , MF 10.0 kΩ 1% 3/8W	326376
R404	" " 9.09 kΩ 1% 3/8W	340354
R405	" " 3.32 kΩ 1% 3/8W	340302
R406	" " 4.75 kΩ 1% 3/8W	340321
R407	" " 8.87 kΩ 1% 3/8W	340353
R408	" , Var. 1 kΩ 20% 1/2W	311284
R501	Resistor, Comp. 470 kΩ 5% 1/2W	301151
to		
R507	" " "	"
R508	" , MF 8.66 kΩ 1% 3/8W	340352
R509	" " "	"
R510	" " 9.53 kΩ 1% 1/2W	326313
R511	" " 165 kΩ 1% 3/8W	340505
R512	" " 866 kΩ 1% 3/8W	340591
R513	" " 499 kΩ 1% 1/2W	326561
R514	" " 49.9 kΩ 1% 3/8W	340442
R515	" " 4.99 kΩ 1% 3/8W	340323
R516	" " 210 kΩ 1% 3/8W	340517
R517	" " 536 kΩ 1% 3/8W	340566
R518	" " 13.0 kΩ 1% 3/8W	340373
R519	" , Var. 1 kΩ 20% 1W	311256
to		
R524	" " "	"
R525	" " 2 kΩ 10% 1W	311264
R526	" , MF 3.24 kΩ 1% 1/4W	340310
R527	" " 3.57 kΩ 1% 1/4W	340320
R528	" " 3.92 kΩ 1% 3/8W	340311
R529	" " 4.75 kΩ 1% 3/8W	340321
R530	" , Comp. 180 Ω 5% 1/2W	301069
R531	" , MF 84.5 kΩ 1% 3/8W	340470
R532	" " 787 kΩ 1% 3/8W	340586
R533	" " 78.7 kΩ 1% 3/8W	340466
R534	" " 392 kΩ 1% 3/8W	340550
R535	" , Comp. 1 MΩ 5% 1/2W	301159
R536	" , MF 143 kΩ 1% 3/8W	340497
R537	" " 536 kΩ 1% 3/8W	340566
R538	" " 54.9 kΩ 1% 3/8W	340447
R539	" " 154 kΩ 1% 3/8W	340501
R540	" , Comp. 1 MΩ 5% 1/2W	301159
R541	" , MF 90.0 kΩ 1% 3/8W	340474
R542	" " 210 kΩ 1% 3/8W	340517
R543	" , Var. 20 kΩ 10% 1W	311266
R544	" , MF 21.0 kΩ 1% 3/8W	340399
R545	" , Comp. 1 MΩ 5% 1/2W	301159
R546	" , MF 38.3 kΩ 1% 3/8W	340428
R547	" " 274 kΩ 1% 3/8W	340531
R548	" , Var. 20 kΩ 10% 1W	311266
R549	" " 48.7 kΩ 1% 3/8W	340441
R550	" " 226 kΩ 1% 3/8W	340521
R551	" " 35.7 kΩ 1% 3/8W	340425
R552	" " 118 kΩ 1% 3/8W	340487
R553	Resistor, Var. 45.3 kΩ 1% 3/8W	326403
R554	" " 110 kΩ 1% 3/8W	340483
R555	" " 36.5 kΩ 1% 3/8W	340426
R556	" " 73.2 kΩ 1% 3/8W	340462
R557	" " 25.5 kΩ 1% 1/4W	340409
R558	" , Comp. 1 MΩ 5% 1/2W	301159
R559	" " 10 kΩ 5% 1/2W	301111
R560	" , MF 26.7 kΩ 1% 3/8W	340410
R561	" " 158 kΩ 1% 3/8W	340504

Reference		Description	BEC Part No.
R562	" , Var.	20 kΩ 10% 1W	311266
R563	" , Comp.	5.1 kΩ 5% 1/2W	301104
R564	" "	"	"
R565	" , MF	39.2 kΩ 1% 3/8W	340430
R566	" "	169 kΩ 1% 3/8W	340506
R567	" "	7.87 kΩ 1% 3/8W	340347
R568	" "	32.4 kΩ 1% 1/2W	340420
R569	" "	97.6 kΩ 1% 3/8W	340477
R570	" "	40.2 kΩ 1% 3/8W	326401
R571	" "	100 kΩ 1% 3/8W	340478
R572	" , Comp.	7.5 kΩ 5% 1/2W	301108
R573	" , Var.	2 kΩ 20% 1/2W	311285
R574	" , MF	27.4 kΩ 1% 3/8W	326394
R575	" "	56.2 kΩ 1% 3/8W	340448
RT401	Thermistor	KB23J1	325009
RT402	"	KB24J1	325010
RT501	Thermistor	100 Ω 10%	325005

(Model 42B-18 only)

R801		P/O Resistor Network	345004
R802	Resistor, MF	47.5 kΩ 1% 3/8W	326404
R803		P/O Resistor Network	345004
R804	Resistor, Var.	5 kΩ 10% 1W	311268
R805	" , MF	5.23 kΩ 1% 3/8W	340326
R806	" , Var.	1 kΩ 20% 1W	311256
R807	" "	"	"
R808	" , MF	15 kΩ 1% 3/8W	340378
R809	" "	2 kΩ 1% 3/8W	326265
R810	" , Var.	50 kΩ 20% 1/2W	311282
R811	" , MF	750 kΩ 1% 3/8W	340583
R812	" , Var.	50 kΩ 20% 1/2W	311282
R813	" , MF	750 kΩ 1% 3/8W	340583
R814	" , Comp.	10 kΩ 5% 1/2W	301111
R815	" "	"	"
R816	" , Var.	50 kΩ 10% 1W	311295
R817		P/O Resistor Network	345004
R818	" , Comp.	1 MΩ 5% 1/2W	301159
R819	" , Var.	10 kΩ 10% 1W	311267
R820	" , MF	47.5 kΩ 1% 3/8W	326404
R821	"	P/O Resistor Network	345003
R822	" , Var.	10 kΩ 10% 1W	311267
R823	" , MF	11 kΩ 1% 3/8W	340364
R824	" "	4.02 kΩ 1% 3/8W	340315
R825		100 kΩ P/O Resistor Network	345003
RT801	Thermistor	1 kΩ 1%	325006

Reference		Description	BEC Part No.
A201	Op. Amp.	LM302H	535003
A501	Op. Amp.	LM301AN	535012
A502	" "	"	"
A503	" "	LM310	535005
*A801	Op. Amp.	LM301AN	535012
*A802	" "	"	"
*A803	" "	"	"
*A804	" "	"	"
CR101	Diode	FD300	535052
CR102	Diode, Signal	1N914	530058
CR103	" "	"	"
CR104	" , Zener	1N5243B	530101
CR105	" "	1N5235B	530089
CR106	" , Signal	1N914	530058
to			
CR110	" "	"	"
CR111	Rectifier, Bridge		532013
CR112	" "		"
CR113			
CR114			
CR115	Diode, Signal	1N914	530058
CR116			
CR117			
CR118	Diode, Signal	1N914	530058
to			
CR124	" "	"	"
CR201	Diode	1N914	530058
to			
CR218	"	"	"
CR 501	Diode	1N914	530058
to			
CR510	"	"	"
*CR801	Diode	1N914	530058
*CR802	"	"	"
IC101	Int. Circuit	Regulator µA7805	535011
IC102	"	" "	"
IC103			
IC104	"	Regulator MFC6030	535007
IC105	"	" "	"
*IC801	Int. Circuit	Dual NPN CA3046	528058
Q101	Transistor	FET 2N5459	528019
Q102			
Q103			
Q104	Transistor	FET 2N5459	528019
Q105	"	FET TIS58	528038
Q106	"	HDGP1000	528066
Q107	"	"	"
Q108	"	FET 2N5459	528019
Q109	"	Selected	528044
Q110	"	2N5088	528047
Q111	"	2N5087	528042

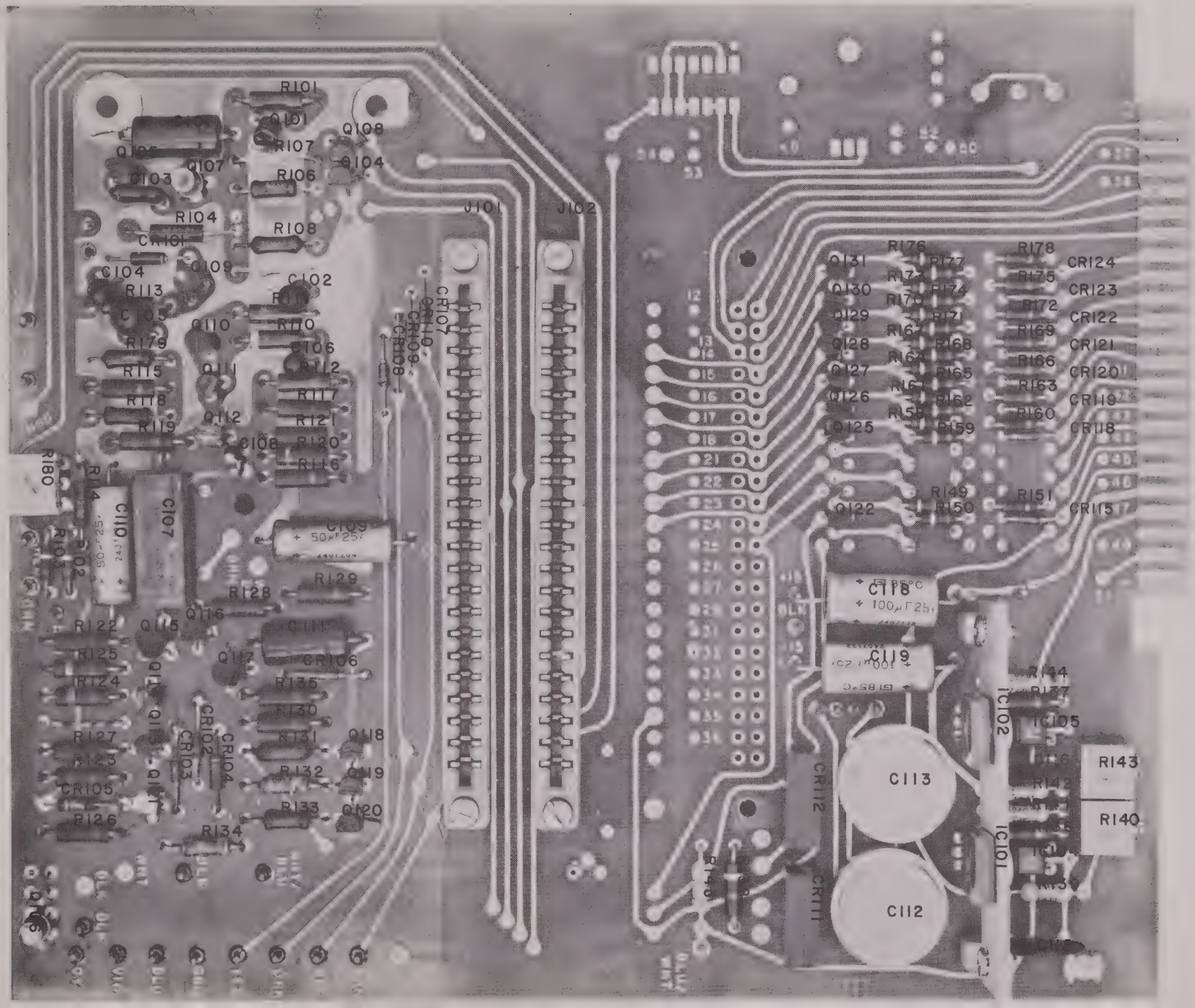
*Used in Model 42B-18 only

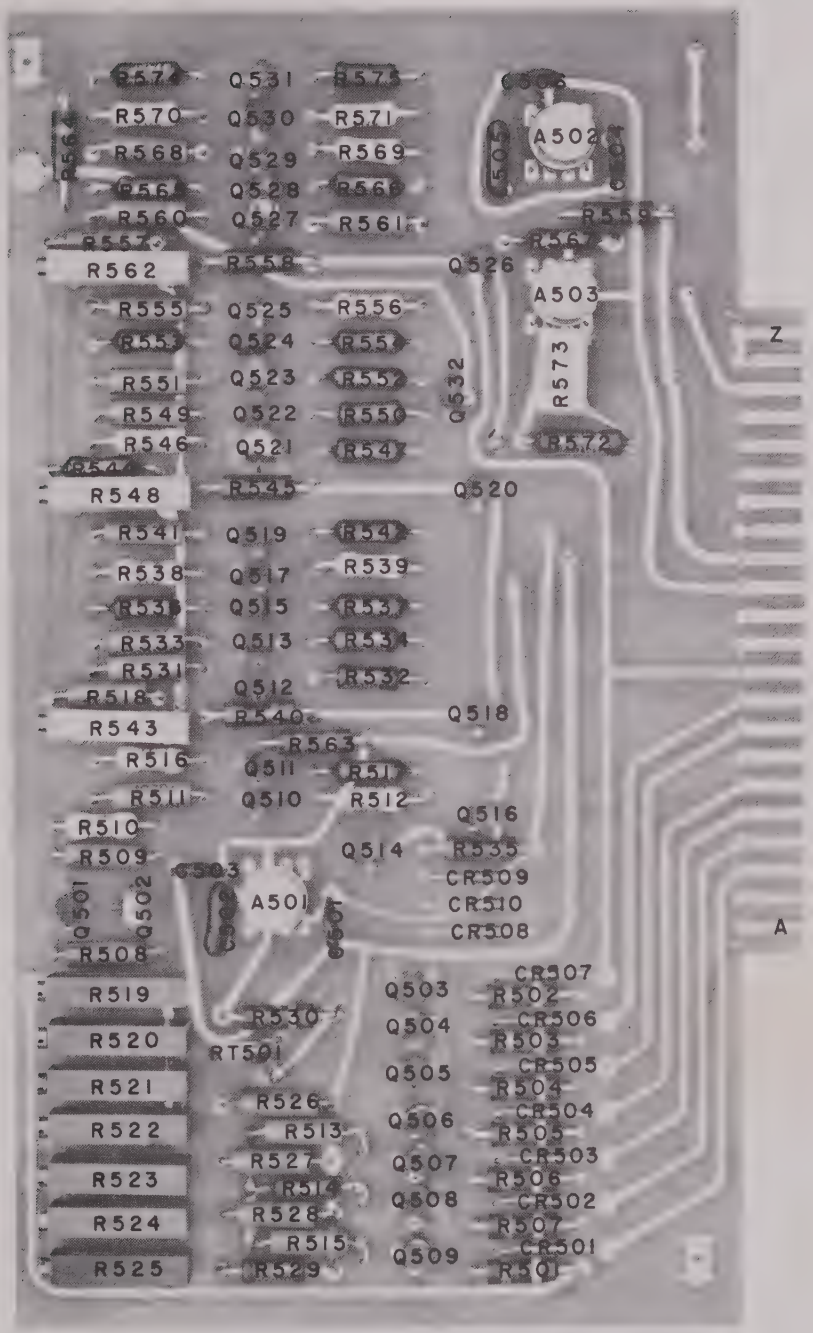
Reference		Description	BEC Part No.
Q112	Transistor	MPSA66	528048
Q113	"	2N5087	528042
Q114	"	2N5088	528047
Q115	"	FET TIS58	528038
Q116	"	"	"
Q117	"	"	"
Q118	"	FET 2N5459	528019
Q119	"	"	"
Q120	"	"	"
Q121	"	MPSA66	528048
Q122	Transistor	MPS 6516	528037
Q123			
Q124			
Q125	Transistor	MPS 6516	528037
to			
Q131	"	"	"
Q201	Transistor	2N4871	528051
Q202	"	NPN MPS-A20	528043
Q203	"	PNP 2N5087	528042
Q204	"	NPN 2N5088	528047
Q205	"	NPN MPS-A20	528043
Q206	"	FET MPS-A12	528052
Q207	"	NPN MPS-A20	528043
Q208	"	FET TIS58	528038
Q209	"	NPN MPS-A20	528043
Q210	"	FET TIS58	528038
Q211	"	FET 2N5459	528019
Q212	"	NPN MPS-A20	528043
Q213	"	NPN 2N5308	528050
Q214	"	"	"
Q501	Transistor	2N5088	528047
Q502	"	"	"
Q503	"	FET 2N5459	528019
to			
Q509	"	"	"
Q510	"	2N5088	528047
to			
Q513	"	"	"
Q514	"	FET TIS58	528038
Q515	"	2N5088	528047
Q516	"	FET TIS58	528038
Q517	"	2N5088	528047
Q518	"	FET TIS58	528038
Q519	"	2N5088	528047
Q520	"	FET TIS58	528038
Q521	"	2N5088	528047
to			
Q525	"	"	"
Q526	"	FET TIS58	528038
Q527	"	2N5088	528047
to			
Q532	"	"	"

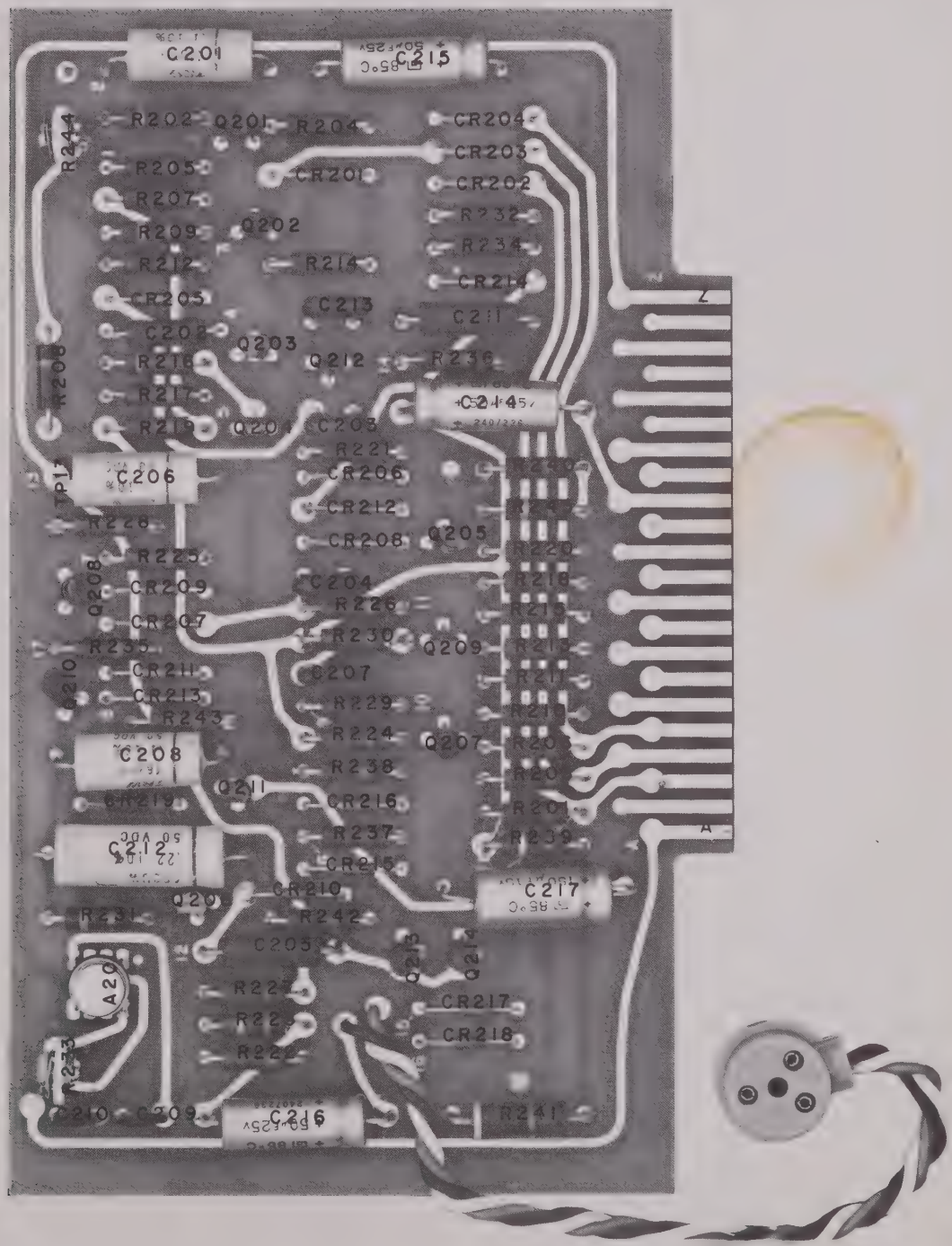
Reference		Description	BEC Part No.
DS401	Lamp	No. 349	545107
DS402	"	"	"
F401	Fuse	1/16 Amp. 220 V	545518
F401	"	1/10 Amp. 117 V	545519
G401	Chopper	Special	540113
M401		Meter & Scale	554286
*M401		"	554289
**M401		"	554290
T401	Transformer	Power	446068

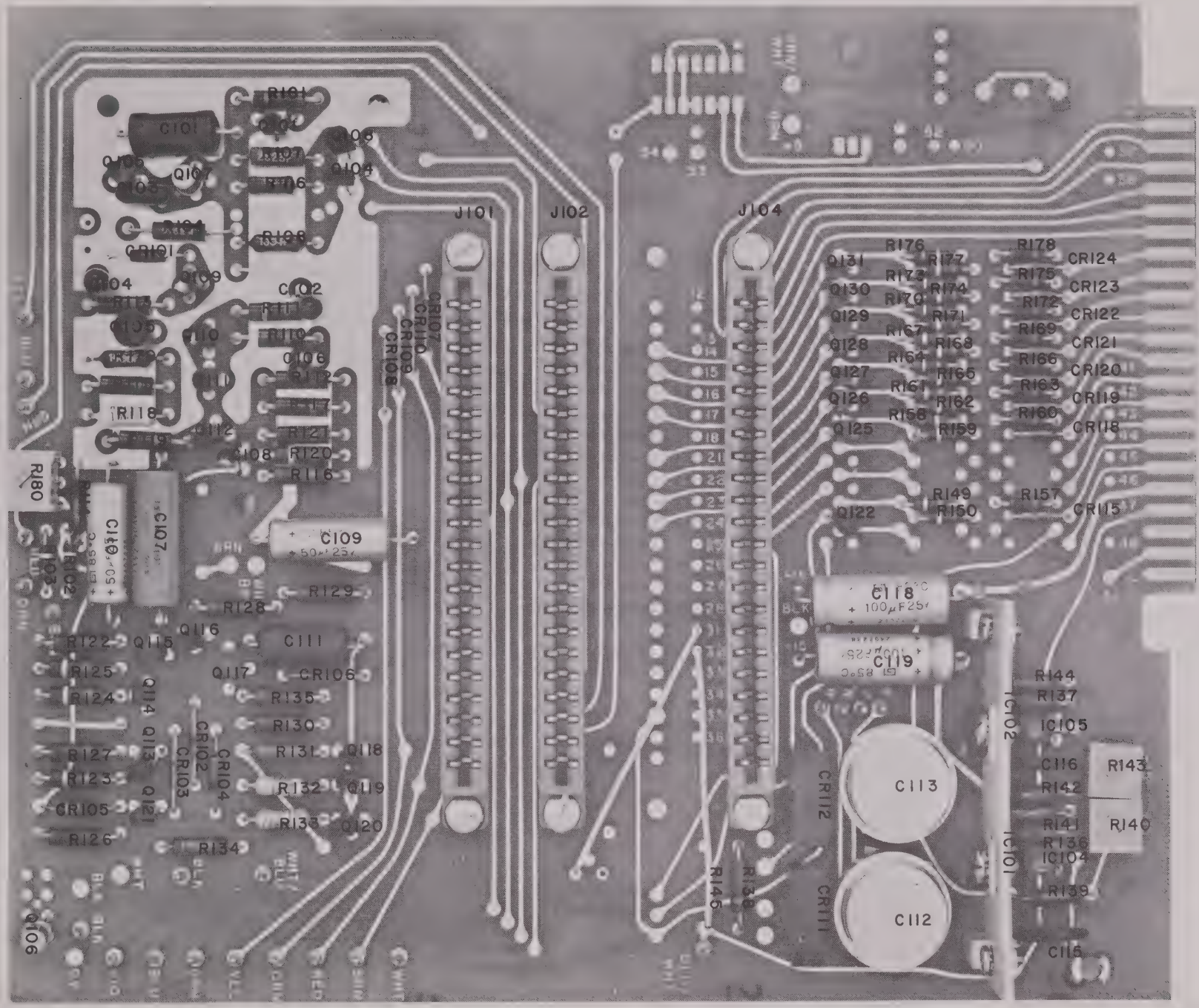
*Model 42B-18 only
**Model 42B-19 only

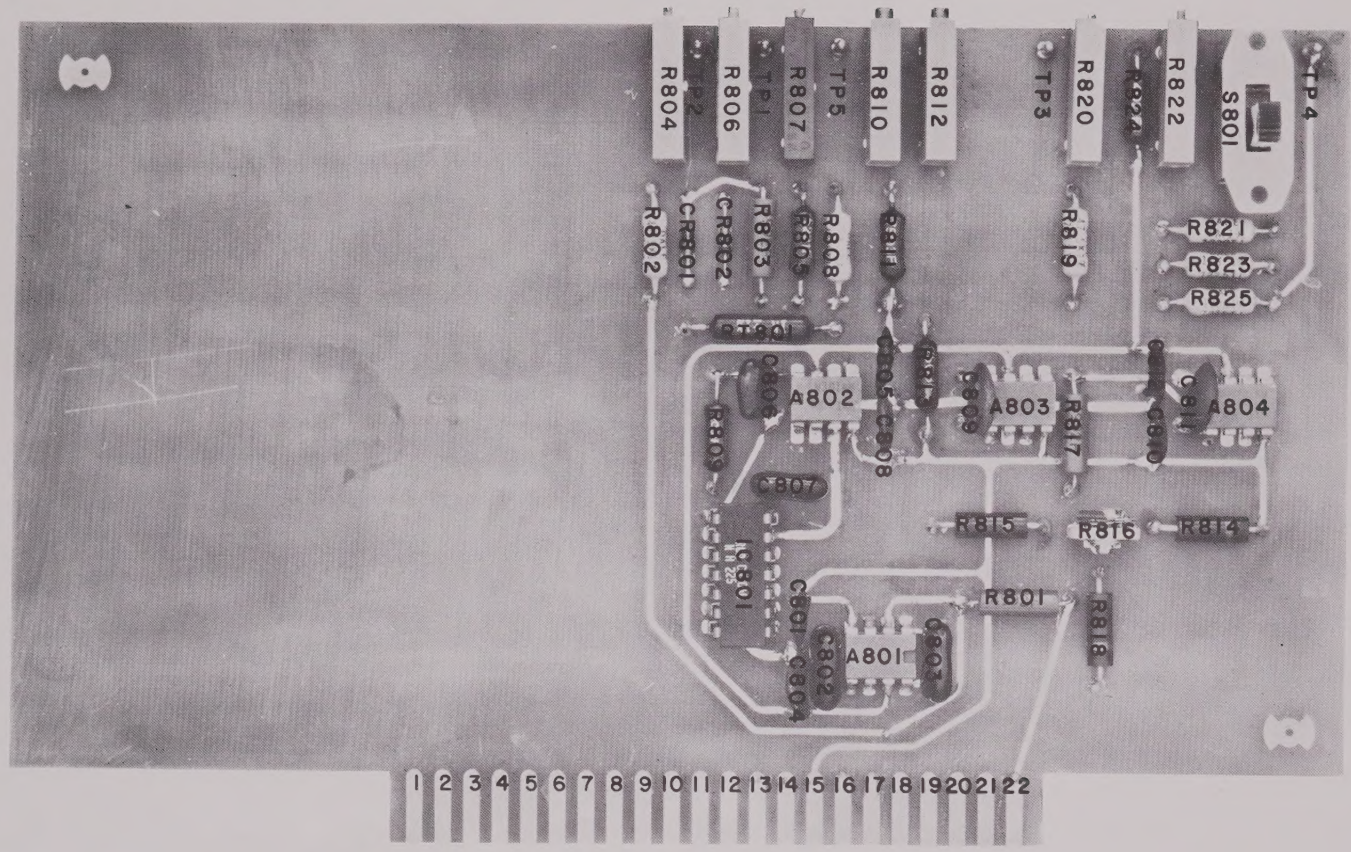
– NOTES –


R101
Q101
Q108
R107
Q106
Q107
Q104
C103
R106
R104
R108
CR101
C104
Q109
C102
R113
C105
Q110
R110
R179
C106
R115
Q111
C112
R118
R117
R119
Q112
R121
C108
R120
R116
R180
C110
C107
C109
+ 50µF25V
R129
R128
Q116
R122
Q115
C111
R125
Q117
CR106
R124
R135
R130
R127
R131
Q118
R123
CR102
CR103
CR104
R132
Q119
CR105
R133
Q120
R126
R134
J101
J102
CR107
CR108
CR109
CR110
R176
R177
Q131
R175
CR124
R172
R174
Q130
R170
CR123
R171
Q129
R167
CR122
R169
Q128
R168
R166
CR121
Q127
R165
R163
CR120
Q126
R162
CR119
R160
Q125
R159
CR118
R149
R151
Q122
R150
CR115
C118
+ 100µF25V
C119
R144
R137
IC102
IC105
R143
C113
R142
R140
IC101
CR112
CR111
C112


R574
Q531
R573
R570
Q530
R571
R568
Q529
R569
R566
Q528
R560
Q527
R561
R557
R562
R558
Q526
R555
Q525
R556
R553
Q524
R551
Q523
R549
Q522
R546
Q521
R548
R545
Q520
R541
Q519
R538
Q517
R539
R535
Q515
R533
Q513
R531
Q512
R532
R543
R540
Q518
R563
R516
Q511
R514
R511
Q510
R512
Q516
R510
R509
Q514
R535
CR509
CR510
CR508
A501
R508
R519
R530
R520
RT501
R521
R526
R522
R513
R527
R523
R514
R528
R524
R515
R529
R525
Q503
R502
Q504
R503
Q505
R504
Q506
R505
Q507
R506
Q508
R507
Q509
R501
CR507
CR506
CR505
CR504
CR503
CR502
CR501
A502
R559
R567
A503
R573
R572
Z
A


C201
C215
R202
Q201
R204
CR204
CR203
R244
R205
CR201
CR202
R207
R232
R209
Q202
R234
R212
R214
CR211
CR205
C213
C211
C202
Q203
R208
R216
Q212
R236
R217
C245
R219
Q204
C203
R221
C206
CR206
CR212
TP1
R226
CR208
Q205
R225
R220
Q208
CR209
C204
R218
R226
R213
CR207
R230
Q209
R215
R235
C207
R211
CR211
Q210
CR213
R229
R243
R224
Q207
C208
R238
R208
Q211
CR216
R237
R239
C212
CR215
C217
CR210
Q206
R242
R231
C205
A20
R227
CR217
R228
CR218
R223
R222
C210
C209
C216
R241


J101
J102
J104
C101
C102
C103
C104
C105
C106
C107
C108
C109
C110
C111
C112
C113
C114
C115
C116
C117
C118
C119
R101
R102
R103
R104
R105
R106
R107
R108
R109
R110
R111
R112
R113
R114
R115
R116
R117
R118
R119
R120
R121
R122
R123
R124
R125
R126
R127
R128
R129
R130
R131
R132
R133
R134
R135
R136
R137
R138
R139
R140
R141
R142
R143
R144
R145
R146
R147
R148
R149
R150
R151
R152
R153
R154
R155
R156
R157
R158
R159
R160
R161
R162
R163
R164
R165
R166
R167
R168
R169
R170
R171
R172
R173
R174
R175
R176
R177
R178
R179
R180
CR101
CR102
CR103
CR104
CR105
CR106
CR107
CR108
CR109
CR110
CR111
CR112
CR113
CR114
CR115
CR116
CR117
CR118
CR119
CR120
CR121
CR122
CR123
CR124
Q101
Q102
Q103
Q104
Q105
Q106
Q107
Q108
Q109
Q110
Q111
Q112
Q113
Q114
Q115
Q116
Q117
Q118
Q119
Q120
Q121
Q122
Q125
Q126
Q127
Q128
Q129
Q130
Q131
IC101
IC102
IC104
IC105


R804
R806
R807
R810
R812
R820
R822
S801
TP4
TP3
TP5
TP1
TP2
R802
CR801
CR802
R803
R805
R808
R819
R821
R823
R825
C806
A802
C805
C808
C809
A803
R817
C810
C811
A804
R803
C807
R815
R816
R814
R801
R818
C801
C802
C804
A801
C803
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

BOONTON ELECTRONICS CORPORATION

Telephone: 201-887-5110
TWX: 710-986-8241
Route 287, Parsippany, N. J. – 07054

BOONTON ELECTRONICS CORPORATION

MP MASTER
MA24768

TEL: 201 - 887-5110
TWX: 710 - 986-8241
ROUTE 287 AT SMITH ROAD
PARSIPPANY, N. J. - 07054